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ABSTRACT

The California Extension Service works with schools to develop energy education programs which will reduce school energy usage and costs by involving staff and students in energy management. This bibliography contains selected materials which present an accurate reporting of the facts, assume little teacher background, emphasize active learning in and out of the classroom, and emphasize energy conservation and quality of life. Listed here are 34 instructional resources for grades 7-12. Resources are organized into five categories: (1) "Interdisciplinary Materials;" (2) "Science Activities;" (3) "History/Social Science;" (4) "Supplemental Activities;" and (5) "Resource Materials." For each set of materials, the grade levels, availability, cost, an abstract, and an example of the activities in the material are presented. (CW)

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ANIMATED BIBLIOGRAPHY

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Bonnie J. Cornwall,
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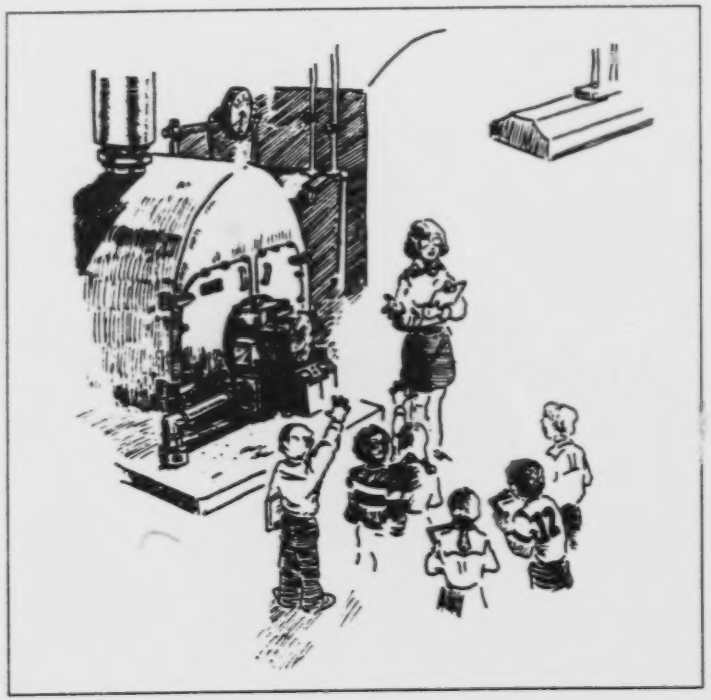
This is by no means a complete listing of available materials. Those selected are fairly accurate in their reporting of energy facts, attractive in format, assume little teacher background in most cases, emphasize active learning in and out of the classroom and emphasize energy conservation and quality of life. Above all, most are free or readily accessible. If you have materials you think should be included, please contact our office.

This 1988 revision of the Animated Bibliography was managed by Bonnie Cornwall and Kim Ortiz. The original version was developed in 1982 by Dana Stokes, with the help of Dickson Schwarzbach, Jan Philbin and Charlene Mathews. A 1985 revision was conducted by Marilyn Bodourian of Cupertino Union School District.

Many thanks to the producers of curriculum materials who provided the California Energy Extension Service with complimentary review copies.

The California Energy Extension Service works with schools in the State of California through seven regional centers to develop energy education programs which reduce school energy usage and costs by involving the school staff and students in energy management. Energy management needs to be practiced by everyone, not just the custodian. Energy education in the classroom helps teachers and students to become partners in reducing school energy costs. If you are not aware of the regional center in your area, please contact the California Energy Extension Service.



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PAGE	TITLE OF CURRICULUM MATERIALS	PLACE OF ORIGIN
1.	Introduction: Building Student Energy Leaders for California's Future	
2.	Energy Concepts for Developing a Local Plan	
	INTERDISCIPLINARY MATERIALS	
3.	Energy '88: Learning about Science, Society and Technology	California*
5.	New York Energy Education Project Activity Guides	New York
6.	Project for an Energy Enriched Curriculum	Dept of Energy/National Science Teachers Assoc.
8.	Energy Crunch (Energy Source)	California*
9.	Energy Conservation for New York State	New York
10.	Energy, Food & You	Washington
11.	Project AIMS	California
13.	Know Nukes	New Hampshire
15.	Energy Reporter and Energy Researcher	California*
	SCIENCE ACTIVITIES	
16.	Science Activities in Energy	Dept of Energy/Naionall Science Teachers Assoc.
17.	Wind, Water, Fire and Earth	Dept of Energy/National Science Teachers Assoc.
18.	Energy Skill Builders (Energy '88)	California*
20.	Exploring Energy (textbook)	Illinois*
21.	Paper Cup Science	California
22.	Thomas Alva Edison Experiment Books	Michigan
	HISTORY/SOCIAL SCIENCE	
23.	Energy in American History (Energy Source)	California*
24.	Electric Gnus (Energina Materials)	California*
25.	Energy Choices & Challenges (Energy Source)	California*
26.	Politics of Energy (Energina Materials)	California*
27.	Electricity Choices	California*
28.	Practical Energy Projects for Industrial Arts	California
29.	The Balancing Act: How Utility Rates are Decided	National Gas Association*
30.	Enernomics (Energina Materials)	California*
	SUPPLEMENTAL ACTIVITIES	
31.	Hidden Costs of Energy, The Oil Rollercoaster	Washington, DC*
32.	National Energy Education Day Project	National
33.	Energy Patrol Packet	California
34.	How to Motivate Staff and Students to Save Energy	California
35.	How to Organize and Communicate your Energy Data	California
36.	Computer Software	Multiple States
37.	Energy Quest	North Carolina*
	RESOURCE MATERIALS	
38.	Energy & Education (newsletter)	National Science Teachers Association
39.	Utility Education Materials Catalog	California*
40.	Renewable Energy Materials	Multiple States*
42.	Non-Renewable Energy Materials	Multiple States*

Materials were prepared by local teachers unless noted by *, which indicates private development.

BUILDING STUDENT ENERGY
LEADERS FOR CALIFORNIA'S FUTURE

Californians use twice as much energy per person as industrial nations with similar standards of living and consume more than 3% of the world's oil even though statistics indicate we have cut our energy use substantially since the oil embargo. Clearly, the need for energy education remains if students are going to understand the finite nature of fossil fuels and make wise energy choices that will shape our destiny for years to come.

Teachers who recognized the importance of energy education had little support from traditional resources just after the oil embargo in the early 1970's, and so many of you developed your own materials by taking some information from the media and utility bill stuffers, adding a pinch of films, resource people and field trips and mixing it all up with a cup or two of home-grown lessons and dittos. The Department of Energy (DOE) developed materials in partnership with the National Science Teachers Association and their national laboratories. The energy industries in California supported the development of materials by local companies such as Energex (now Educational Development Specialists), Enterprise for Education and Innovative Communications which are now recognized as some of the best materials nationwide. As the "crisis" appeared to abate, the funds to make materials available dwindled. The result is that some good materials, particularly from the Department of Energy, are no longer readily available. Luckily for Californians, some of those materials and most of the best commercially available kits are still available free through local utility companies.

When energy education is mentioned, there is a tendency to think—science. To be sure, as indicated in a 1984 statewide survey of teachers conducted by the California Energy Education Forum (CEEF), more energy concepts are taught by science teachers than any other group. Teachers in subjects other than science and social studies were less likely than others

to teach energy. That is unfortunate because energy education is a good vehicle for stimulating growth and developing student abilities to:

- collect, examine and criticize information,
- think in a disciplined and logical manner,
- communicate ideas and feelings through listening, speaking, reading and writing, and
- expand schooling into their personal lives.

Ninety percent of teachers felt energy was important enough to accommodate a new unit in the curriculum, but adding another topic to an already full day is not likely to occur. Energy education, however, need not be a new unit, and perhaps is more effective infused into the curriculum so that students understand how pervasive energy is. Nearly 70% of teachers surveyed said they would consider replacing a unit with one on the same topic that included energy examples. Energy awareness can be increased by using energy examples to **teach basic skills**. For example, many of the activities have students interpret graphs. (See *How To Organize Energy Data* or meter reading activities.) *Know Nukes* is particularly effective in getting kids to separate fact from opinion. Energy simulations can also **reinforce basic concepts**. Government classes can role play how a bill becomes law. (See *Politics of Energy* and *NEED Project*.) Economics classes can plan the family energy budget. Classes studying the industrial revolution could examine how the emergence of oil led to the development of the corporation as we know it. (See listings related to American History in the Table of Contents.) Those studying modern life around the world could examine the need for energy causes people of third world countries to enter the cash economy in *Project for an Energy Enriched Curriculum*. That type of inquiry takes students **beyond the basics**.

Both the Governor and Legislature have formally recognized the importance of energy education. In 1987 and 1988, the Governor declared the third Friday in March as Energy Education Day. Assembly Bill 1733, signed by the Governor in 1985, calls on the Superintendent of Public Instruction to "take any steps necessary to encourage school districts to provide some form of energy education instruction."

Most of you, according to the CEEF survey, already make your own energy education materials rather than get them from other sources. It is the hope of the California Energy Extension Service that this *Animated Bibliography* will not only give you a source of materials and teaching ideas which you indicated you needed, but actual lessons that can be taught in

the classroom tomorrow. Energy education should be, as an educator in Massachusetts noted, "a thread woven into the school's overall curricula. It is now time to move statements supporting energy education from letterhead pieties into action programs."

ENERGY CONCEPTS FOR DEVELOPING A LOCAL PROGRAM

Energy concepts are recognized in the recommendations contained in the *State Frameworks* and *Addendums* prepared for various subject areas by the State Board of Education. In particular, the *State Science Framework* emphasizes energy in the physical sciences and introduces it in discussions of photosynthesis, ecosystems, astronomy and geology. The section on "Energy: Sources & Transformations" is the most comprehensive.

To guide you in your selection of activities, a broad list of concepts that would comprise a comprehensive interdisciplinary program is noted below that was used in the CEEF survey in 1984. A third of the concepts were taught by both science and non-science teachers and most of the concepts were checked as essential by at least 40% of teachers. Four concepts in particular were taught by a majority of teachers at all grade levels:

1. **Most energy on earth comes from the sun.**
2. **All human activities require energy.**
3. **Some energy sources are renewable.**
4. **Wise energy choices will conserve energy.**

In addition to those noted above, the following concepts were taught by at least 38% of non-science teachers at the secondary level.

- As fossil fuels become depleted, the cost of extracting them increases.
- Individuals and societies make choices about energy supply and use.
- Government and business actions influence energy supply.
- Over the years, the mix of energy sources used by Americans has changed.
- Energy supply and use is the major source of pollution.

In addition to the four major concepts, the following were taught by a minimum of 51% of junior high teachers. (Those in **bold type** were taught by over 75% of high school science teachers.)

- **When energy is transformed, a portion is converted to heat.**
- **Energy flows through a chain beginning with green plants.**
- As fossil fuels become depleted, the cost of extracting them increases.
- **All human activities require energy.**
- Over the years, the mix of energy sources used by Americans has changed.
- Energy supply is a major source of pollution.

In addition to concepts taught by junior high teachers, 51% of senior high science teachers taught the concepts below.

- Energy is lost from a food chain beginning with green plants.
- Getting energy requires an expenditure of energy.
- When choosing a source of energy, it is important to consider the economic, environmental and social costs and benefits.

North Carolina offers a similar, yet distinct way of approaching the selection of activities and that is through a set of learner-directed goals for energy education. Overall, learners should understand that:

1. There are many sources of energy.
2. Energy can be converted from one form to another.
3. Energy resources and their availability for human activity vary.
4. There are many uses of energy.
5. There are wise and efficient management practices which can extend the useful life of earth's energy resources.
6. Energy development and use create impacts on environmental and economic systems.
7. Our energy future may be different from that of the past or present.

ENERGY '88: Learning About Science, Society and Technology
Interdisciplinary materials

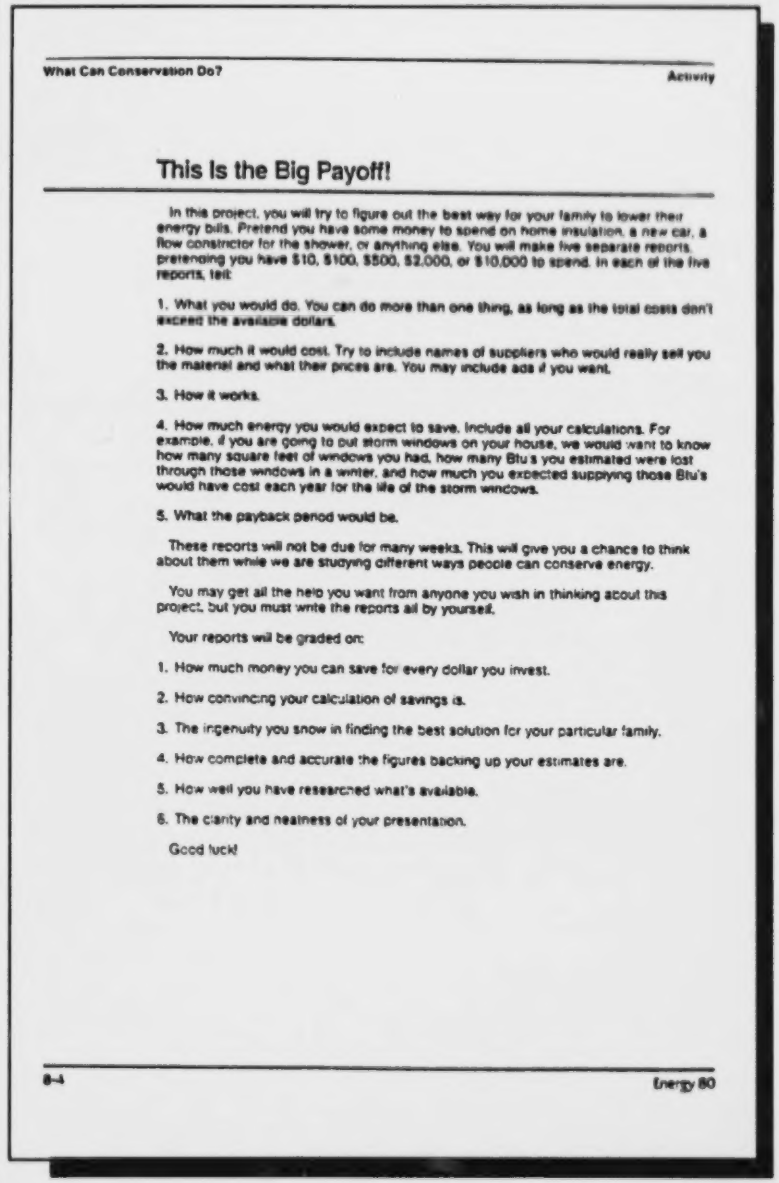
Grades: 7 through 12.

Available From:
Enterprise for Education
1320 'A" Santa Monica Mall, #202
Santa Monica, California 90401, (213) 394-9864

Cost: No charge to many California districts due to industry sponsorship. Contact the publisher for information on funded districts.

The ENERGY '80 Program is built around a 60-page student guide that is a masterful blend of exceptionally well-written text and brilliant, colorful graphics. The 1988 guide presents a sequence of major energy concepts, beginning with energy transformations, proceeding to energy sources and utilization and concluding with energy conservation. The work is known for its two-page spreads on such topics as the energy cycles, consumption from 1859-1985, refining petroleum, a day in the life of a utility, nuclear fuel cycle, demand, "spaghetti" diagram of production and consumption, buying energy abroad, investing in energy and climate and comfort, to name a few. Each spread stands alone and provides the context for a set of activities while, the author notes, "helping students realize there is a forest during daily lessons about trees."

The 160-page teacher's guide outlines a teaching strategy and mini-quiz for each. In most cases, the materials are so well designed and organized that little teacher background is needed. For each energy concept, there is at least one supplemental activity which is presented in a multi-volume set of resource books. The seven volumes consist primarily of lesson plans containing information for the teacher as well as black line masters of activity sheets, readings, bulletin board materials, etc. The set consists of an introduction, energy fundamentals, energy flows in nature, fossil fuels/renewables/conservation, nuclear, energy use in the United States and energy economics. The books range from 100 to 300 pages with nuclear being the longest. A set costs $35. *Energy Skill Builders*, annotated as another entry, supplement these materials.



What Can Conservation Do? Activity

This Is the Big Payoff!

In this project, you will try to figure out the best way for your family to lower their energy bills. Pretend you have some money to spend on home insulation, a new car, a flow constrictor for the shower, or anything else. You will make five separate reports, pretending you have $10, $100, $500, $2,000, or $10,000 to spend. In each of the five reports, tell:

1. What you would do. You can do more than one thing, as long as the total costs don't exceed the available dollars.

2. How much it would cost. Try to include names of suppliers who would really sell you the material and what their prices are. You may include ads if you want.

3. How it works.

4. How much energy you would expect to save. Include all your calculations. For example, if you are going to put storm windows on your house, we would want to know how many square feet of windows you had, how many Btu's you estimated were lost through those windows in a winter, and how much you expected supplying those Btu's would have cost each year for the life of the storm windows.

5. What the payback period would be.

These reports will not be due for many weeks. This will give you a chance to think about them while we are studying different ways people can conserve energy.

You may get all the help you want from anyone you wish in thinking about this project, but you must write the reports all by yourself.

Your reports will be graded on:

1. How much money you can save for every dollar you invest.

2. How convincing your calculation of savings is.

3. The ingenuity you show in finding the best solution for your particular family.

4. How complete and accurate the figures backing up your estimates are.

5. How well you have researched what's available.

6. The clarity and neatness of your presentation.

Good luck!

8-4 Energy 80

Investing in Energy

Susie Homeowner's energy bills are going up. What can she do about it?

1 Susie's house has storm windows, but no insulation. She asks insulation contractors and the utility company to suggest things she could do to save energy and money.

Jack, Jane & Jim Investor, who live in a small Rocky Mountain town, have saved $50,000. They would like to use their savings to make more money.

2 To do that they have to find something people need and will buy. Energy is something people in their town need. Could they sell energy?

2

things to do	price	annual saving
caulking and weatherstripping	$100 (do-it-herself)	$117
insulate attic	$750	$153
insulate crawl space	$200	$26

How much Susie saves each year depends on the price Susie has to pay for energy. She expects to keep her house five more years, and thinks the price of energy will rise 10% per year during those years. If so, an insulated attic would save Susie $224 in the fifth year, and an insulated crawl space $38.

3 It looks pretty obvious that weatherstripping and caulking would be a good thing to do. In the first year she will get back all she spent and $17 more. After that, she will save at least $117 a year until the caulking wears out.

But it isn't so clear whether Susie should spend the $750 for the attic or the $200 on the crawlspace. Susie needs to find out what her costs and savings would be during the five more years she expects to keep the house.

Money Out

5 Every investment has some risks. The forest could burn down. A freak storm could destroy the windmill. The greater the risk seems to be, the greater the return needed to attract a rational investor like you.

All ways of getting energy cost something. There is only so much money with which to do things, so we have to decide what to do first. One way of deciding what to do is to choose those projects that will return the most money for each dollar spent.

If you were one of the investors, what would you choose to invest the $50,000 in?

possibility	left after 25 years
firewood	$362,668
wind generator	$528,290
bank account	$466,754

8 For the crawl space, Susie discovers that at the end of five years she would have $79 less than the $308 she'd get by leaving the $200 in the bank. Susie decides to insulate her attic, but not the crawl space. Instead, she is figuring out whether it would pay to trade in her old car for one that uses less gas.

Some ways of saving energy are free, but we often have to spend money to save energy. We get the money invested back in savings on energy bills. The smart thing is to do first the things that will save the most money per dollar invested.

year	money saved by end of year	interest earned at 9%	year-end cash
1	$153 + $113 tax credit	$0	$266
2	$168	$24	$458
3	$185	$41	$684
4	$204	$62	$950
5	$224 + $500 resale value	$86	$1760

Money In

7 They could set up a firewood business. They could buy 100 acres of wooded land for $40,000. For $10,000 more they could get a truck and equipment to cut and haul the wood. If they cut only as much wood as grows each year, they would get 100 cords per year, which could be sold for $16,000 a year. But they would have to pay for gasoline, truck, and saw maintenance, and the wood-cutter's wages, which they estimate would total $15,000. They think the value of the land, the price of wood, and wages and other costs will go up about 7% a year. They figure out that if they did this, banking earnings at 9%, at the end of 25 years the value of the land and the profits would be $362,668.

4 Or they could put their money in certificates of deposit in the bank, where it would earn 9% interest. If they did this, at the end of 25 years they would have $466,754.

3 They could buy a wind generator for $37,800 plus $12,200 for shipping, land, and installation. At 7¢ a kWh, they could get $3500 for the electricity generated the first year, and maintenance the first year would cost $200. They think this cost and the selling price of the electricity will go up 7% a year. They can invest earnings at 9%. The machine should last for 25 years, and then the land and machine could be sold for $1000. At the end of 25 years, they would have $528,290.

4 Susie has saved money that is earning 9% interest each year. If she leaves the $750 in the bank, at the end of five years she will have $1155, and $308 if she leaves the $200 the crawl space would cost. On the other hand, if she could lower her energy bills, she could save the extra money and earn interest on it.

7 Susie takes $750 out of the bank and insulates the attic. In five years she will have $1760 instead of the $1155 she would have if she left the money in the bank. She will be $605 ahead!

6 Susie will also save some taxes. Congress allows you to deduct 15% of the first $2000 you spend on insulation from your income tax. $750 × 15% = $113; $200 × 15% = $30

5 Susie calls a friend who is a real estate agent. He says he thinks that buyers five years from now might pay $500 more for her house if the attic was insulated, but they might not realize insulation in the crawl space was valuable.

NEW YORK ENERGY EDUCATION PROJECT
ACTIVITY GUIDES
Interdisciplinary unit

Grades: 5 through 12

Available From:
Energy Education Project SUNY - Albany
1400 Washington Avenue
Box 22100
Albany, New York 12222, (518) 381-2243

Cost: $4.00 (teacher's guide is $1.60)

The Project is co-sponsored by the State University of New York, the New York Department of Education and electric utilities. Four student activity guides, produced in 1985, are available including Energy Conservation, Renewable Energy, Fossil Fuels, and Nuclear. A fifth packet, "Energy Options", has a series of 21 one-page readings on energy and sources, each with a vocabulary list and questions. The presentation is even-handed and the activities are interesting. For example, one of the solar activities is on solar land use ordinances. The Conservation book contains six activities on conservation in buildings, transportation and appliances. The Renewables book contains seven activities on solar, wind and biomass, as well as values and attitudes. The Fossil Fuel book has 9 activities on the formation, conversion and use of fossil fuels; their role in U. S. history and environmental effects. The Nuclear book has 7 activities on the basics, technologies and economics. There are also two sets of diagrams and graphs for duplication: Energy Facts and Energy Sources and Technologies.

For each unit, there is a suggested teaching strategy for a 4-day to 6-week unit at various grade levels. Each activity is formatted to include objectives, skills and knowledge required, materials, vocabulary, procedure, questions, review and ideas for further exploration. A matrix highlights how materials can be used in Industrial Arts, Home Economics, Math, Economics and English classes. Although some activities could easily be infused, they are best used as complete units of study. According to one reviewer, "this is a well conceived learning unit."

Part 1

America and the Automobile

Automobiles consume a large percentage of the total amount of fossil fuels used in the United States. In the following exercises you will be analyzing several different visuals to obtain information about automobile fuel consumption.

Section A: Interpreting Cartoons About Automobile and Fuel Use

The following cartoons give several different points of view on automobile fuel consumption and United States energy policy.

Directions: Examine each cartoon and then answer the questions about the cartoon.

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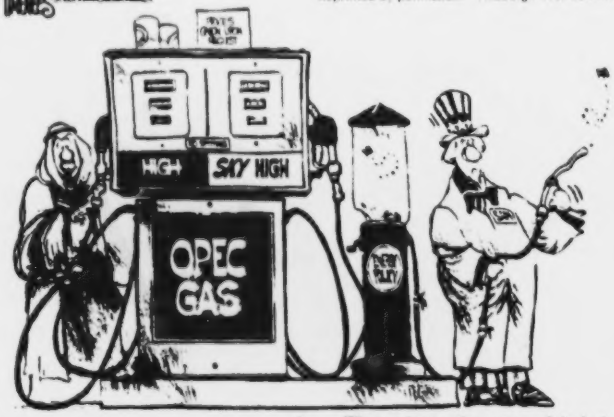


Questions

1. List everything that you see in this cartoon.
2. Which fossil fuel does this cartoon relate to?
3. What is the name of the cartoonist?
4. In which newspaper did this cartoon first appear?
5. What does the man dressed as an Arab represent?
6. What does the man labeled "SAM" represent?
7. In the opinion of this cartoonist, who is having success?
8. In the opinion of this cartoonist, does the United States have a good energy policy?
9. What is the main idea of this cartoon?
10. What do you think the cartoonist is exaggerating in this cartoon?

PROJECT FOR AN ENERGY ENRICHED CURRICULUM
Energy unit/curriculum guide

Grades: 7 through 12 (Social Studies with some Science emphasis)

Available From:
California Energy Extension Service
1400 Tenth Street
Sacramento, California 95814, (916) 323-4388

Cost: No charge for single copy

This series of 9 packets was produced in the late 1970's by the National Science Teachers Association for the Department of Energy to link energy, environment and economics issues. They are still classics from which you will see many other authors have drawn. Each packet is geared to a particular grade level and contains student materials as well as background information for teachers, lesson overviews, learning objectives and teaching strategies. The packets are by no means thin, with most of them well over 100 pages. They are simply produced and thus the student section is easily reproducible. Although some of the topics such as "U. S. Energy Policy— Which Direction?" are a little dated, the framework provided for exploring the topic is quite thorough and the informative charts and tables that frequent the packets can easily be updated as a research activity.

The activities go beyond the more typical topics examined in other materials and often raise some controversial issues as students weigh evidence, make choices, evaluate consequences. Basic skills such as reading, listening, writing and working with numbers are reinforced.

Mathematics and Energy: Grades 7 and 8
A wide range of energy problems using fractions, decimals, graphs, conversions, statistics and manipulation of energy units such as watts, calories and joules.

Transportation and the City: Grades 8 and 9
Social Studies lessons dealing with concept of efficiency and the effects of the auto on the urban landscape. "L.A.— City of Windshields" is particularly relevant. Science lessons apply supply and demand calculations to oil resources and present experiments related to new transportation technology.

Energy Transitions in U. S. History: Grades: 8 and 9
Charts the growth of United States energy use and history of major sources.

Energy, Engines and Industrial Revolution: Grades 8 and 9
Social Studies lessons focus on the relation of energy to the growth of cities, industry and inventions. Science lessons relate to energy sources and conversions with special attention to the heat engine.

Energy in the Global Marketplace: Grades 9 through 11
Explores energy in world trade and the global balance of power. Examines the differences between the energy "haves and have-nots" and gives students a sense of their place in the world.

How a Bill Becomes Law to Conserve Energy: Grades 9 through 12
Activities focus on the legislative process with a simulated hearing on the 55 mph speed limit adapted from the actual hearing record. Exercises on graph construction and interpretation included.

Agriculture, Energy and Society: Grades 10 through 12
Basic energy-economics facts of food production and economic themes such as profit and loss,a dn the law of diminishing returns. Science lessons build skills in data analysis, graph interpretation and under standing basic energy units and their conversions.

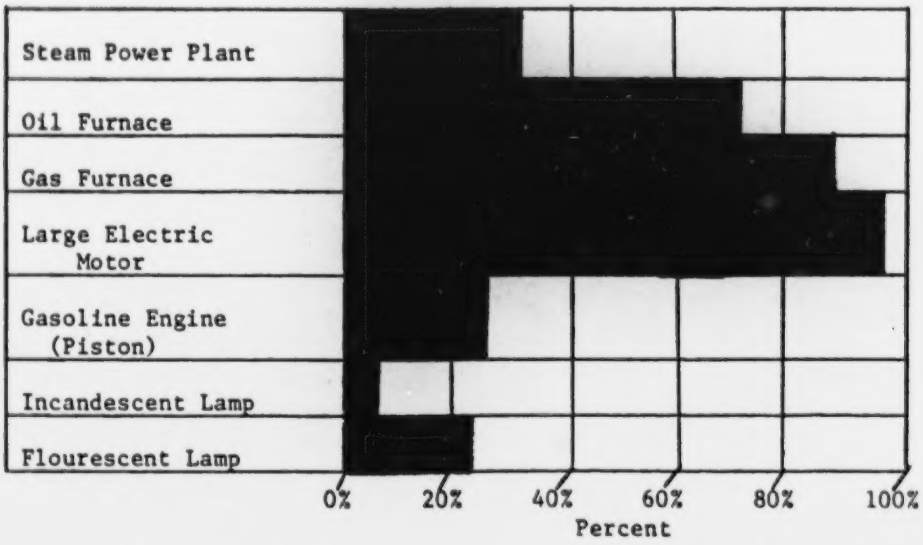
Western Coal: Boon or Bust?: Grade 11
Investigates energy resources in the West and studies the effects of large scale resource development on the economy and environment.

U. S. Energy Policy: Which Direction?: Grades 11 and 12
A companion to the unit on *How a Bill Becomes a Law*, which focuses on the legislative branch, this unit looks at the administrative arm of government and its role in national policy.

Lesson 4
Student Worksheet

1. The "efficiency" of an energy source is measured by a comparison of the output (in energy, time, money, etc.) with the input of the same quantity. The following bar graph shows:

PERCENTAGE OF ENERGY USED WHICH IS CONVERTED TO USEFUL WORK[1]



a. What percent of energy is converted to useful work for each plant, furnace, etc.?

(a. Steam Power Plant 33%
Oil Furnace 74%
Gas Furnace 88%
Large Electric Motor 98%
Gasoline Engine (Piston) 25%
Incandescent Lamp 6%
Flourescent Lamp 23%)

b. Which of the above energy sources is most efficient?

(b. Large electric motor is most efficient.)

c. Least efficient?

(c. Incandescent lamp is least efficient.)

d. Discuss the efficiency of each energy source. What causes them to be less efficient?

(d. General reasons for lesser efficiency:
--amount of heat loss
--amount of friction
--energy of another type produced [other than type being measured for purpose intended])

ENERGY CRUNCH
Part of the Energy Source Program
Self-contained curriculum kit

Grades: 7 through 9 grade (Science)

Available From:
Southern California Gas
San Diego Gas & Electric Company
Modesto Irrigation District

For further information:
E.D.S.
5505 East Carson St., Suite 250
Lakewood, California 90713
(213) 420-6814

The intent of this two or three week unit is to present both sides of various energy issues and explore the reasons for the "crunch." The emphasis is on obtaining facts and forming individual opinions. Energy Sleuth, Sy Malone involves students in the energy crunch case. Students identify energy terms and concepts as well as the problems of energy supply and demand, extending fossil fuels and developing future energy sources. They analyze sources to come up with ways to solve the case. The student book contains chapter review exercises and a glossary. Teacher materials are complete and easy to use. Class demonstration materials include posters, two filmstrips and cassette tapes, as well as materials for students and families to use at home. Pre- and post-tests are useful for evaluation.

Learning Objectives:
1. Energy Basics -- conversions, potential and kinetic
2. Energy Supply versus Energy Demand
3. Conservation
4. Basics of fossil fuels, solar, nuclear and others
5. Sources -- Pros and Cons

Chapter 3

Conservation: Our Not-So-Secret Weapon

One part of the solution to the energy crunch is to keep our demand for energy from growing so fast. During the 1950's and 1960's, America's demand for energy was increasing about four or five percent every year. At this rate of growth, our energy was doubling every 20 years.

During the 1970's and into the 1980's, energy shortages, inflation, and other factors have caused energy prices to rise dramatically. Because of the rise in prices, our growth rate of energy use has slowed considerably. We're actually using less energy now than we were in the late 1970's.

Part of this slowing down of our energy use was because of *conservation*. There are two basic approaches to conservation: *careful use* and *improved technology*.

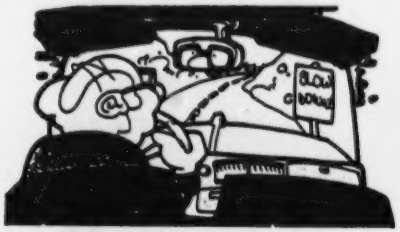
Careful use means that each of us uses energy wisely without wasting it. It does not mean, however, that we have to "sacrifice" or "give up" comfortable lifestyles. Careful use simply means that each of us decides to do our part to help save energy. Often, this means changing old, wasteful habits.

Improved technology means changing the design and building of cars, appliances, houses, and other energy users so that they are more energy efficient. Efficient energy users can do the same work while using less fuel. An example is a well-engineered car that gets more miles to each gallon of gasoline. Improved technology takes time and money, but it can save a lot of energy.

Let's look at how conservation through careful use and improved technology is being practiced in each sector of our society -- transportation, residential and commercial, and industrial.

Transportation

The transportation sector uses about 25 percent of our energy. Conservation is very important in this sector because transportation depends almost totally on liquid fuels made from oil. Finding large amounts of cheap oil is a problem that will continue through the rest of this century.



Careful Use

Private cars account for about half of the energy used for transportation. Thus, many of the ways we can save energy through careful use involve cars. For example, we can form or join carpools to go to work or school, use public transportation (buses, trains, subways) when possible, obey the 55 mile-per-hour speed limit, and buy fuel-efficient cars.

Improved Technology

In 1975, the U.S. Congress passed a law that required car makers to build more fuel-efficient cars. The law said that new car fleets were to have an overall average of 18 miles per gallon of gasoline by 1978 and 27.5 miles per gallon by 1985. These standards may become even higher in the future. Fuel-efficient cars can save millions of barrels of oil and billions of dollars.

To save fuel, the car makers have designed smaller, lighter cars with more efficient engines. Other vehicles are also becoming more fuel-efficient. For example, newer, lighter metals are being used to build airliners. The lighter a vehicle, the less fuel it needs to run.

Mass transit systems using subways, buses, and commuter trains can result in large gasoline savings because fewer private automobiles are used. But these systems require a lot of time and money to build and are probably most practical in densely populated cities.

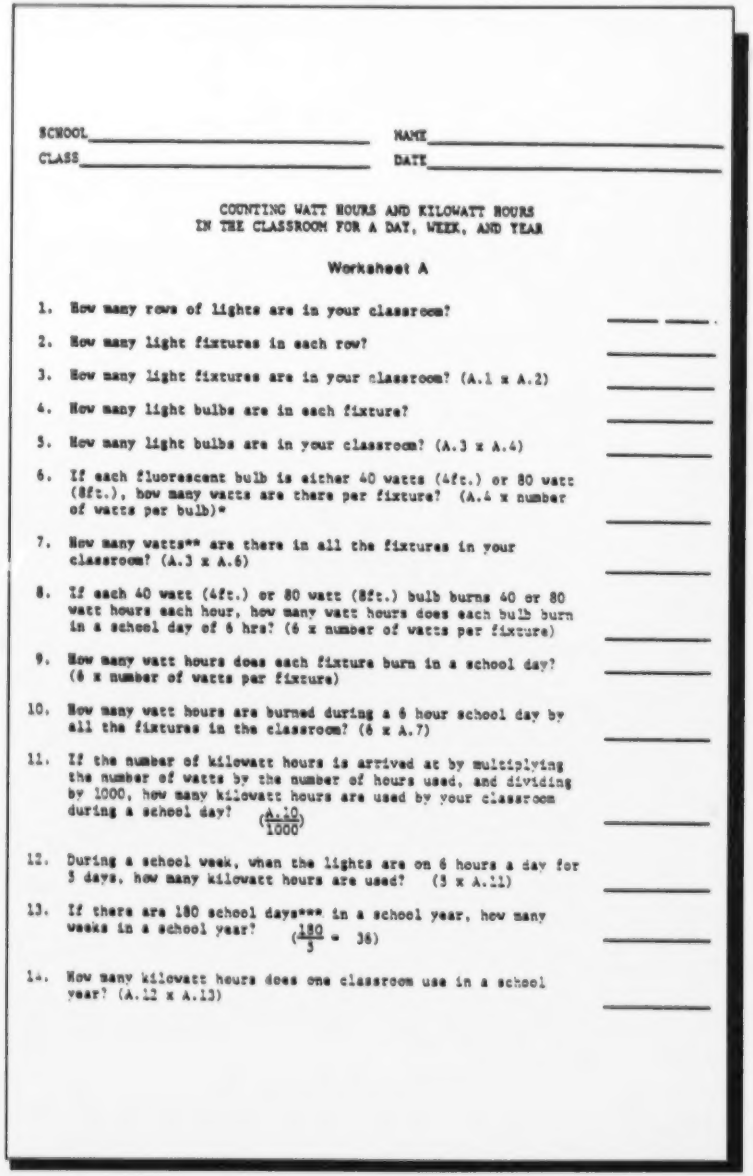
ENERGY CONSERVATION EDUCATION FOR NEW YORK STATE
Interdisciplinary materials

Grades: 4 through 9

Available From:
New York State Energy Office
Two Rockerfeller Plaza
Albany, New York 12223
[518] 473-4315

Cost: 1 free copy to teachers

These materials, developed in the late 1970's take a "concentric circle" approach— developing student awareness of their immediate classroom environment and then providing them with experiences in the ever widening spheres of the school building, home, neighborhood and city and at large. There is no conceptual sequence to the 18 lessons, although each of the four sections represents a "ring" in the concentric circle. The first section provides introductory experiments for classes beginning to study energy. In the second, the focus is on classroom electricity as students perform a lighting audit, keep a log of consumption and graph electricity savings. (This unit makes a good companion to the Energy Patrol activity described as another entry in this bibliography.) The final unit includes a good lesson as preparation for a visit to a power plant, a comparison between fluorescent and incandescent lights, energy careers and famous men in energy history. Instructions are provided for constructing a simple solar collector and wind generator to use in labs. Materials were designed by teachers. Individual pages can be removed for copying.



SCHOOL_____ NAME_____
CLASS_____ DATE_____

COUNTING WATT HOURS AND KILOWATT HOURS
IN THE CLASSROOM FOR A DAY, WEEK, AND YEAR

Worksheet A

1. How many rows of lights are in your classroom? ____ ____.
2. How many light fixtures in each row? _____
3. How many light fixtures are in your classroom? (A.1 x A.2) _____
4. How many light bulbs are in each fixture? _____
5. How many light bulbs are in your classroom? (A.3 x A.4) _____
6. If each fluorescent bulb is either 40 watts (4ft.) or 80 watt (8ft.), how many watts are there per fixture? (A.4 x number of watts per bulb)* _____
7. How many watts** are there in all the fixtures in your classroom? (A.3 x A.6) _____
8. If each 40 watt (4ft.) or 80 watt (8ft.) bulb burns 40 or 80 watt hours each hour, how many watt hours does each bulb burn in a school day of 6 hrs? (6 x number of watts per fixture) _____
9. How many watt hours does each fixture burn in a school day? (6 x number of watts per fixture) _____
10. How many watt hours are burned during a 6 hour school day by all the fixtures in the classroom? (6 x A.7) _____
11. If the number of kilowatt hours is arrived at by multiplying the number of watts by the number of hours used, and dividing by 1000, how many kilowatt hours are used by your classroom during a school day? $\left(\frac{A.10}{1000}\right)$ _____
12. During a school week, when the lights are on 6 hours a day for 5 days, how many kilowatt hours are used? (5 x A.11) _____
13. If there are 180 school days*** in a school year, how many weeks in a school year? $\left(\frac{180}{5} = 36\right)$ _____
14. How many kilowatt hours does one classroom use in a school year? (A.12 x A.13) _____

ENERGY, FOOD & YOU
Interdisciplinary curriculum guide

Grades: K through 8; 9 through 12

Available From:
Washington State Office of Environmental Education
17011 Meridian North
Seattle, Washington 98133
(206) 542-7671

Cost: $7.00 per volume with $1.50 postage and handling

With either of these thick activity guides in hand, you are guaranteed to stimulate the creative mind of any student as they delve into titles such as, "How Far Did Your Breakfast Travel?" or "Grandma Had No McDonalds". The 300-page guides, developed in 1979 and revised in 1985, provide an excellent source of information and activities dealing directly or indirectly with food production and related energy topics. The premise of the books is that a careful study of the food system should lead to an understanding of energy— what it is, why we need it and how we can conserve it. Activities are organized by eleven concepts, some of them familiar in energy curricula such as renewable and non-renewable sources of energy, hidden energy requirements and transformations, and other more related to the energy consumed in getting food to us and the nutritional value of food. Each guide is divided into three sections: Global Food and Resource Needs, Energy and the U. S. Food System and energy Efficient Nutrition. An additional section on the basic characteristics of energy is provided in the secondary guide.

Lessons can be infused, taught as a separate unit and/or used as independent study. The index makes infusion easy because it lists activities by subject area— social studies, language arts, health, math, art, music, science. The format for each activity includes the concept addressed, discipline, grade level, objectives, materials required, procedures, bibliography and a few even have teacher comments. Some lessons are oriented to the Northwest but can be easily adapted.

ACTIVITY TITLE: "Drawing" Attention to Energy Sources (game)
CONCEPT: Although the sun is the primary source, there are many sources of energy. Some energy sources are renewable and some are non-renewable.
SUBJECT AREA: Science, Art
GRADE LEVEL: Primary
OBJECTIVE: To understand that most of our energy comes from the sun.
MATERIALS: Crayons
4 large sheets of butcher paper
ACTIVITY:
1 Divide the class into group is given a number.
2. Each member of the small group is given a number.
3. Provide each group with crayons and 1 large sheet of butcher paper.
4. At a starting signal, number one from each group runs up to the teacher who whispers the same energy source to them.
5. They run back to their groups and draw that source, not talking, until someone whispers the correct identification.
6. Number two runs to the teacher, whispers the answer and if correct, receives the second item on the list to draw.
7. Progress through 10 items.
8. Remind students they must whisper the answer or another team will overhear.
9. Discuss team cooperation and consideration.

Suggested terms:

1. Food	6. Oil
2. Wind	7. Gasoline
3. Water Power	8. Garbage
4. Sun	9. Wood
5. Ocean Currents	10. Compost

BIBLIOGRAPHY & RESOURCES:
Energy and Conservation Education, activities for the classroom, grades 1-3, Energy & Man's Environment Inc (EME), Portland, Oregon,97201
Oregon Department of Energy, *The Family Energy Watch Calendar*, Department of Energy, 528 Cottage Street, NE, Salem, Oregon, 97310, $1.50

A variation of the game "Pictionary".

PROJECT AIMS
Hands-on activities

Grades: K through 9 (interdisciplinary)

Available From:
AIMS Education Foundation
Post Office Box 7766
Fresno, California 93747
(209) 291-1766

Cost: $10.95 each (plus 6-1/2% sales tax and 10% shipping)

Project AIMS is a non-profit venture administered by Fresno Pacific College. The project began as a National Science Foundation grant to train teachers to integrate math and science, but has since developed to include language arts and other subjects. Since the mid 1980's, over 180 teachers have participated as writers and a matching number have field tested activities that are compiled into about 20 books. Each 50 to 100 page volume consists of a teacher manual with all the information about the investigation and how to prepare for it and a student manual with recording sheets and written or pictorial directions for each activity.

Not all of the energy activities are included in one book, but *Popping with Power* (3-4), *Math + Science = A Solution* (5-9) and *Pieces and Patterns* (5-9) have numerous energy activities interspersed with the 20 to 30 activities in each volume. *Exploring for Fossil Fuels in a Bran Muffin,* is one favorite. The Correlations with the Science Framework Addendum for grades K-3, 3-6 and 6-9, are a tremendous aid for teachers wanting activities for particular concepts such as *Energy Takes Many Forms* or *Conversion of Energy From one Form to Another has Consequences for the Environment.* This correlation makes it easy to use energy examples to teach basic concepts. Teachers may need to apply some of their own creativity to note more of the energy applications of the activities. For example, an activity on measuring shadows does not discuss the implications for siting homes to use passive solar energy.

CARTONS 'N COTTON

I. **Topic Area**
Insulation—Energy Conservation

II. **Introductory Statement**
Students will discover the effectiveness of insulation.

III. **Math Skills**
a. Measuring
b. Computing—Subtraction with regrouping

Science Processes
a. Gathering and recording data
b. Observing and classifying
c. Predicting and hypothesizing
d. Interpreting data

IV. **Materials**
(per group)
3 small jars with lids—all same size (large baby food jars work great)
3 half-gallon milk cartons
glue
cotton balls (about 250-300)
thermometer
hot tap water
worksheet

V. **Key Question**
How do we use a blanket or covering to keep things warm?

VI. **Background Information**
It is helpful for the teacher to know that the carton with the cotton on the inside will be noticeably warmer than the other 2 cartons.

VII. **Management**
1. Three class periods of 45 minutes each. It is better to make the insulated milk cartons one day and do the experiment the next. The math paper was completed the third day.
2. Groups of 4-6 are recommended. Size of groups should be determined by the number of thermometers and supplies available.
3. Before passing milk cartons out to the students, the teacher needs to cut a door large enough for easy access to the jars.
4. It is better to have three thermometers per group, but it can be done with just one.

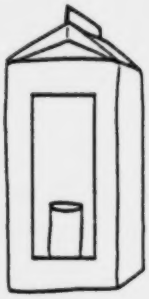
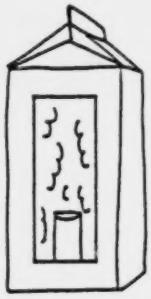
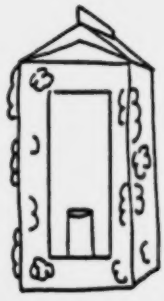
VIII. **Procedure**
Day One
Assign groups. Pass out glue, cotton balls, and milk cartons. Students will glue cotton balls on the inside of one carton and on the outside of the second carton. Be sure students include all sides, top, and bottom. The third carton will remain untouched.
Day Two
Collect all necessary materials. Give each student a worksheet. Go through "What the Students Will Do" step by step. As the students are waiting during the first 15 minute timing period have them sequence the steps gone through so far. The teacher can write these on the board for the students to copy. This gives the student a set of directions to use at home. Don't forget to include the gluing of cotton balls from the previous day. Record temperatures after the second 15 minute period. Discuss what is happening.
Day 3
Do computation on worksheet. Discuss results.

IX. **What the Students Will Do**
1. Students will insulate one carton by gluing cotton balls to the inside of the carton on all sides, top, and bottom.
2. Students will insulate one carton by gluing cotton balls to the outside of the carton on all sides, top, and bottom.
3. Students will leave the third carton untouched.
4. Fill all three jars with the same amount of hot tap water.
5. Put a thermometer in each jar and record temperature on worksheet. If group has only one thermometer work quickly but give the thermometer time to register in each jar.
6. Remove thermometer and place lids on jars.
7. Put each jar in a milk carton and close door.
8. Wait 15 minutes.
9. Remove jars and record temperatures one by one being careful not to mix the jars up.
10. Replace lids and return jars to same milk cartons and close the doors.
11. Wait 15 minutes.
12. Remove jars and lids. Record temperatures.
13. Discussion.
14. Do computation on worksheet. Discussion.

POPPING WITH POWER

NAME _____

CARTONS 'N COTTON

	BEGINNING TEMP	15 MINUTE TEMP	30 MINUTE TEMP
			
			
			

KNOW NUKES
Self-contained curriculum guide
Interdisciplinary unit on nuclear power

Grades: 9 through Adult

Available From:
Antioch/New England Graduate School
Roxbury Street
Keene, New Hampshire 03431
(603) 357-3122

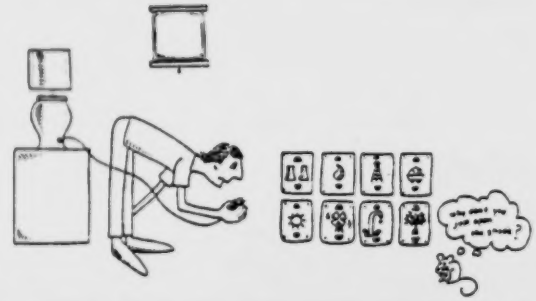
Cost: Available free to those in the PG&E service territory

This 250 page spiral book is full of graphics, charts, photographs and excerpts from a wide variety of original sources. The approach takes full advantage of the nuclear power controversy to encourage study and critical thinking.and makes it easy to introduce the controversial topic of nuclear energy into English, Social Studies and Science and Technology classes. The book developed from a two-week teacher training program funded by National Science Foundation that stimulated four years of workshops and field testing. One of the goals of the program is to introduce teachers to a variety of techniques to integrate science education and current affairs while emphasizing the link between technical information and participatory decisionmaking. Each of the seven units covers a different aspect of nuclear power by stating challenges and problems, providing teacher guidelines and articles from some of the most current material available. The moral issues, unresolved questions and conflicting data are not omitted as students are plunged into "real life" situations. Students are asked to design a nuclear power plant, develop an opinion about low-level radiation exposure standards, determine town policy about a proposed nuclear waste dump and design a brochure describing the relationship between nuclear power and nuclear weapons. None of the tasks can be adequately performed unless the student first learns the necessary technical information. Teachers can implement sections without using the whole book. The final chapter is one teacher's outline of an entire curriculum complete with exam questions. In a rather unusual but important approach, the program is described as "controversial issues education" whose purpose is to promote public debate, discussion and analysis.

In particular, the authors hope to teach students how to separate bias and propaganda from factual information. Although propaganda is often disguised as fact, it is distinguished by its intent to convince the reader to believe in statements stemming from deep ideological conviction. In the nuclear power debate, both utilities and citizen groups have strong biases. The great value of these materials is that they encourage both students and teachers to take a fresh look at their convictions and examine difficult issues in a new light.

WHEEL OF FORTUNE: The Nuclear Fuel Cycle

Choose Your Fuel



Purpose

This activity challenges you to critically compare and contrast the fuel cycles of oil, uranium, coal, natural gas, water, wind, wood, and the sun. During the next couple of weeks, you will research, investigate, and advocate that one of these fuels be used to generate power for a 300-megawatt power plant. In addition, you will learn whether creative and practical conservation measures can eliminate the need for such a plant. With this knowledge, you will be able to make responsible decisions on how to provide for your home and community's energy needs.

Background

If you ever own a home, you'll be faced with many decisions concerning how to fuel your cookstove, heat your water and rooms, refrigerate your food, illuminate your lights, cool your house, and power your stereo. Even if you don t own a home, you'll be living in a community concerned with providing its residents with their electrical needs.

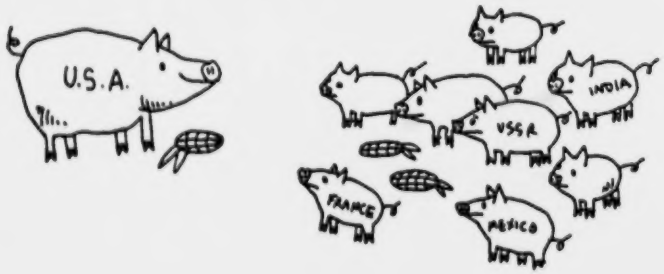
In either case, your selection of fuels will probably consist of the following: coal, water, uranium, oil, natural gas, wind, wood, and the sun. But how will you choose your fuel? What criteria will you use to aid your decision-making? Will your choices be based on availability or locality? On its environmental soundness during production or during home use? On its costs for installation or operation? Or on its renewability or convenience? These are only a few variables that must be weighed when deciding how to bring energy into your home, business, or community.

While nuclear energy is relatively inexpensive and abundant, the consequences of a serious radioactive leak are frightening; although the volume of waste produced by a nuclear power plant is relatively small, the duration for which this waste must be isolated from the environment will extend for generations. While coal is considered our nation's number one resource, its lifespan is limited; although it is extremely efficient when burned, it is accused of producing acid rain. Although solar, wind, water, and wood are renewable, they each present environmental trade-offs and their practicalities are regional.

While oil, natural gas and coal appear abundant and accessible, the projected lifespan (in terms of availability) of the nonrenewable fuels ranges from forty years for natural gas to five hundred years for coal, and the lifespan of uranium remains unclear.

If every fuel inherently contains a trade-off, then how can one intelligently choose? How does one resolve paradoxes like "nuclear power is an inexpensive risk" and "solar power is an expensive freebie"?

Even though the United States only represents about 6% of the world's population, we consume more than 33% of the energy consumed worldwide. As developing cultures become more technologically dependent, the total consumption of energy will increase at phenomenal rates. Given an earth that is trying to support a population that will increase by another billion in less than fifteen years, it is foreseeable that our nonrenewable resources are destined for exhaustion.



Challenge

You are fortunate, however. You have more foresight and knowledge about this matter than our ancestors. For the next couple of weeks, you will be living in Silverton, Vermont. Silverton is a community wise enough to look into her future and realize the need for an additional 300 megawatts, at least enough to meet the demands of growth. Silverton also values community decisions on issues affecting the entire town.

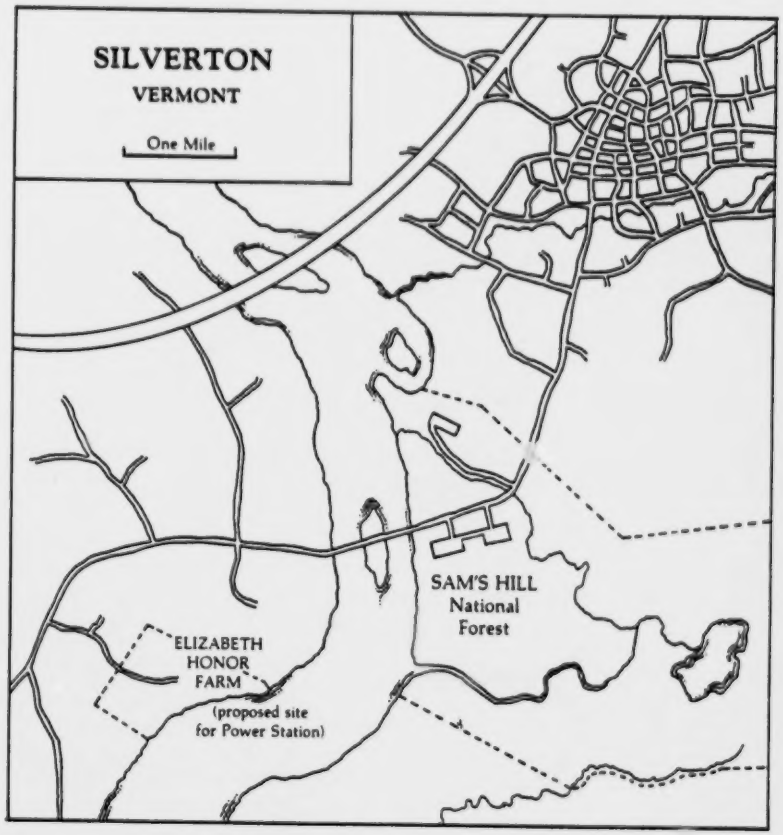
A relatively small power company, called Vermont Edison, services Silverton. This power company has recently projected that by the year 2000, Silverton will require an additional 300-megawatt power plant to meet the growing demands of its residential and industrial sectors. Due to an innovative policy change at Vermont Edison, the citizens of Silverton have been asked to choose their future fuel source.

In response to this request, the Silverton Board of Selectmen has hired nine engineering firms to help the town make its decision. As a representative of one of the engineering companies, you are responsible for educating the selectmen about one of the following energy resources: oil, uranium, natural gas, coal, water, wind, wood, the sun, or conservation. The board has made it clear that they will choose the fuel with the least environmental impact on their community as well as on other communities.

Your goal is to convince the board that your fuel is affordable, environmentally sound, and sufficient to satisfy their increased electrical demands. Therefore, you will need to illustate to the board every step your fuel takes from its mining to its arrival at the power plant, and from its use at the plant to the disposal of its waste products.

SILVERTON, VERMONT—A DESCRIPTION

1. The town owns a 400-acre parcel of farmland left in the will of Elizabeth Honor. Her only qualifier was that it be used for the well-being of the townspeople. The Board would like to consider this property for their proposed electric power generating station.
2. Granite bedrock is at an average depth of 20 feet below the land surface.
3. A major river is one of the borders of the proposed site.
4. Unemployment rate is at 15% for the town. A majority of those unemployed have not completed their high school education.
5. Sam's Hill is a National Forest maintained as a recreational area. It can hold as many as 800 campers during the summer months. Sam's Hill is located within 5 miles of the proposed site.



ENERGY REPORTER and ENERGY RESEARCHER
Single topic lessons

Grades: 9 through 12

Available From:
Several Utilities including
Pacific Gas & Electric

Cost: Free in utility service territory

For Further Information:
Electric Power Research Institute
Post Office Box 10412
Palo Alto, California 94303
(415) 855-2000

The series of 4-page pamphlets was prepared for the Electric Power Research Institute during 1982 and 1983. EPRI is funded by member electric utilities nationwide and conducts research for them. These materials may as well be called the "Electricity From" series because each pamphlet provides background on a different source of electricity. That report is followed by discussion questions and vocabulary. Graphically, they are very polished with text being broken up by photographs and diagrams. Classroom sets are available that include a teacher's guide, suggested student activities and supplemental readings.
A brief description of REPORTER topics follows: Electricity: Overview of a versatile energy; Acidic Precipitation: Collecting the Clues; Electric Vehicles; Transmission and Distribution; and Electricity from Chemistry: The Fuel Cell. The remaining seven are divided by energy source: coal, geothermal, nuclear fission, fusion, solar, hydro and wind.

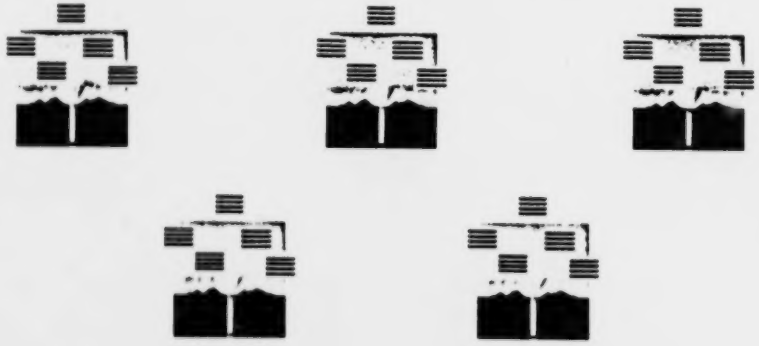
The RESEARCHER series is similar in content, although the discussion presents electric utility research and development in a non-technical manner. RESEARCHER does not have student questions, vocabulary or teacher's guides, but provide supplemental information. Topics covered are virtually the same with the addition of high-voltage transmission, load management and power plant performance and reliability.

EPRI ELECTRIC POWER RESEARCH INSTITUTE

ENERGY REPORTER

Electricity From the Earth: Geothermal Energy

An enormous supply of heat energy lies beneath the earth's surface. Tapping it and turning it into electric power is a challenge that science and industry are trying to meet.



A volcano erupts, sending clouds of steam and hot ash into the sky. A geyser jets a column of water into the air every hour. Hot springs of scalding water bubble and boil all year round. Such natural phenomena are dramatic evidence of the tremendous reservoir of *heat energy* that lies beneath the earth's cool surface.

The forms of this *geothermal* ("earth heat") *energy* vary, but their common source is an interior furnace of rocks heated to the melting point. A reservoir of heat energy, due in part to the conversion of *kinetic energy* (energy associated with motion) to heat energy during the earth's formation and in part to the natural decay of radioactive elements, lies under every square foot of the earth's surface.

If even a small fraction of this energy could be recovered, it would offer an impressive promise of power. In the United States alone, more than 220 quadrillion *Btu* of known geothermal resources are usable for generating electricity. (A Btu—British thermal unit—is the amount of heat needed to raise the temperature of one pound of water one degree Fahrenheit.) When you compare the known geothermal resources with the total U.S. energy consumption for 1980 (less than 80 quadrillion Btu), you can see why energy planners are interested in geothermal resources.

Accessible geothermal energy falls into three broad categories: *hydrothermal systems*, *geopressured systems*, and *petrothermal systems*. Hydrothermal systems are generally considered to offer the best potential for generating electricity in the near future; geopressured and petrothermal systems are longer-term possibilities.

Hydrothermal Systems

The hydrothermal resources—*dry steam hydrothermal* and *hot water hydrothermal*—are the smallest geothermal resource class, making up about 10 percent of the total. But because more is known about recovering and using this type of energy, hydrothermal systems hold the most promise for power generation in the near future.

A dry steam hydrothermal system usually is present where the earth

SCIENCE ACTIVITIES IN ENERGY
Energy experiments

Grades: 4 through 12 (Science)

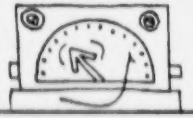
Available From:
Pacific Gas & Electric

Cost: Free

Students making discoveries on their own is the rationale behind this set of nine activity packets developed in the late 70's by Oak Ridge University under contract to the U. S. Department of Energy with assistance from teachers at Lawrence Hall of Science at UC Berkeley. Well designed and attractively presented, these packets are some fo the most frequently "borrowed" energy activities and their signature is unmistakable. The front of each file folder has teacher instructions followed by pull-out sheets which contain from 11 to 6 activities or experiments. Each activity begins with a question and graphically directs the inquiry to its conclusion. The time required for each varies, but all foster open-ended exploration and are designed to be infused into general science courses. Activities need not be completed in sequence and rely on materials readily available like paper cups, water, salt, etc. Each sheet is easily reproducible or can be projected on a screen.

Some elementary physical science is needed to explain the "why" of the concepts. For some packets, process skills, objectives, backgroung, precautions, strategies and results are outlined for the teacher. Packets are available for biomass (growth, energy storage and use of vegetation as fuel), solar (optics, heat transfer, photovoltaics), wind (measurement and machine design), conservation (temperature, heat and efficiency), chemical (storage, conversion, electricity and heat), electricity (electromagnetism, generation, fluorescent lighting, motors, meter reading), storage (batteries, kinetic, pneumatic and hydraulics). Conservation II and Solar II are geared to 7-12 level. The packets are guaranteed to add pizzazz to any science program and makes science relevant by asking questions like "will your bike coast twice as far if your tires have more pressure?"

How much energy is saved when a dimmer switch is used with a 100-watt bulb?



CONSER-VATION 8

Materials

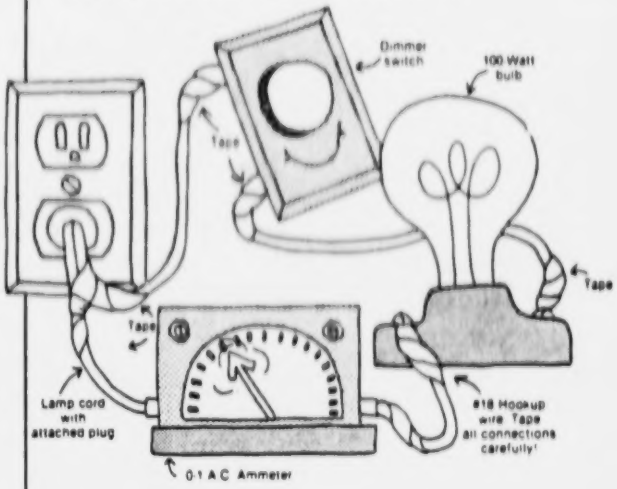
- Ceramic socket
- Lamp cord with attached plug
- 100-, 60-, and 25-Watt bulbs
- 2 Meters of #18 hookup wire (stranded and insulated)
- Electrical tape
- Photo light meter*
- Metric ruler
- Dimmer switch
- 0-1 A.C. Ammeter

*available at camera stores, borrow one from a photographer, or make your own (see ***Conservation II, Activity 6***)

Note

The room must be almost dark!

Set Up And Conduct Your Experiment



Using the different bulbs, measure and record the light output in foot-candles at 30 cm and the current in amps at each dimmer setting.

Bulb size		Amps	Light output in foot-candles
100 Watt	No dimmer		
	½ Output		
	¼ Output		
60 Watt	No dimmer		
	½ Output		
	¼ Output		
25 Watt	No dimmer		
	½ Output		
	¼ Output		

Summary Question

Which method saves more energy for the same amount of light output: using lower wattage bulbs or dimming higher wattage bulbs?

WIND, WATER, FIRE AND EARTH
Energy Activities

Grades: 9 through 12 (Physical Sciences)

Available From:
National Science Teachers Association
1742 Connecticut Avenue, NW
Washington, DC 20009
(202) 328-5800

Cost: $9.00

This collection of 19 lessons, each with a collection of activities, is designed to integrate applied energy concepts into the standard physical science curricula. You will find lessons for chemistry, physics and geology, earth, physical and general science classes. Activities, both laboratory-based and homework, examine the following: outlook for energy supplies, first and second laws of thermodynamics, basis of nuclear power and power plant operation, biomass conversion, synfuels, automobile engines and improving miles per gallon, appropriateness of energy sources, greenhouse effect and global temperature, use of water to extract and transport energy and electricity generation. Since the activities cover a wide age and subject range, a teacher would probably only be able to use a few activities per course. The lessons are particularly well suited to those teachers with access to a science lab.

Although completed in 1986, the lessons and the reference articles are five years old and from heretofore, unpublished units in the Project for an Energy-Enriched Curriculum (PEEC). (The packets were not published due to policy changes at the U. S. Department of Energy.) Teachers may want to obtain more current references to update the materials. CEES staff would be happy to help locate such data.

Student Handout 3-4

Modeling a Chain Reaction

THE MOUSETRAP CHAIN REACTION

Perhaps you can demonstrate how the fission of one nucleus also emits neutrons that can fission additional nuclei by rigging a mousetrap so when it is sprung, additional mousetraps are sprung as well.

Attach a string to the trigger for one trap (see diagram below). Then attach strings from the gate of the first trap to the triggers of two more traps. Attach strings from the gates of these two traps to the triggers of four more traps. Continue until you have used all the mousetraps. Be sure the strings are fairly tight; if they are not, the first trap may not spring the others. Spring the first trap.

1. What happened?

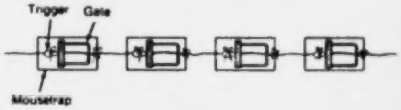
Match the component of the chain reaction of nuclear fission with the corresponding component of the mousetrap system.

NUCLEAR FISSION	MOUSETRAP SYSTEM
2. neutron	A. mousetrap
3. fissioning a nucleus	B. string
4. fissionable nucleus	C. potential energy of mousetrap
5. energy available from fission	D. pulling a string

TIPPING OVER THE DOMINOES

Can you simulate a chain reaction by arranging a set of dominoes? How would you set them up?

6. What represents the fission of a nucleus in a domino arrangement?
7. The chain reactions of the dominoes and the mousetraps illustrate "runaway" reactions that could get out of control. In a nuclear reactor, the sequence of fission is controlled to release energy gradually. How does the mousetrap arrangement below show a controlled reaction?



8. Write an explanation or draw a picture to show how you would rearrange the dominoes to demonstrate a controlled reaction.
9. Does the sequence of mousetraps in the arrangement in question 2 represent a mass of uranium that is (a) subcritical (b) critical, or (c) supercritical? Why?
10. How would you describe the mass of uranium represented by the mousetrap arrangement used at the beginning of this lesson—subcritical, critical, or supercritical? Why?

Student Handout 3-5

Random Order of Nuclear Fission

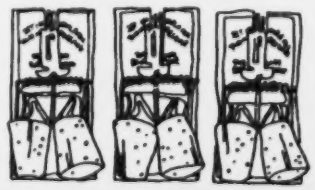
The arrangements of mousetraps and dominoes we have seen so far represent sequences of fissions with known orders of fissioning. In an actual reactor the sequence in which nuclei are fissioned is more random. You can demonstrate this by assembling and setting mousetraps in a regular arrangement with two corks mounted on each gate, as shown in the picture below. Toss in a cork and answer the questions that follow.

CAUTION: MOUSETRAPS ARE EXTREMELY SENSITIVE. DO NOT PLACE YOUR FINGERS IN THE WAY OF THE GATE. ALSO, DO NOT LOOK DIRECTLY DOWN AT THE TRAPS WHEN CORKS ARE SET ON THEM. WHEN A TRAP SPRINGS, IT CAN THROW A CORK AS HIGH AS 1.5 m.

1. What happened? (Note: if nothing happened, toss in another cork. Repeat this process until something happens.)
2. What does each cork represent?
3. Did the "happening" represent a subcritical, critical, or supercritical mass of uranium?
4. Make a "fence" form the sides of a cardboard box, 0.5 to 1 m high. Reset the mousetraps. Put the two corks on each trap as before. Then put the fence around the entire arrangement. Before you toss in a cork, write what effect you think the fence will have on the number of traps that spring. Explain. Then toss in a cork (repeat until a least one trap springs).
5. a. How many traps snapped? How close was your guess?
   b. What percentage of 32 mousetraps is this?
6. Now remove every other mousetrap in checkerboard fashion and reset the remaining 16 traps with 2 corks each. Place the "fence" around them. If you toss in a cork, what effect will removing every other mousetrap have on the percentage of traps that spring? Give a reason.
7. How many mousetraps sprang? What percentage of 16 mousetraps is this? How close was your guess?
8. Regroup the 16 mousetraps in a closely-spaced array. Reset the corks and place the "fence" around the set-up. Toss in the cork. How many mousetraps sprang? What percentage of the total is this?
9. Compare your answers to 8 and 5b. What does this comparison tell you about the relationship between the number of mousetraps and the percentage that spring?
10. Compare your answers to questions 8 and 7. What is the effect of spacing between mousetraps on the percentage that spring?

OPTIONAL

Investigate the effect of suspending strips of flypaper above the array of mousetraps. What do you think will happen? What functions as the flypaper in a nuclear reactor?



ENERGY SKILL BUILDERS
Single topic lessons

Grades: 7 through 12

Available From:
Enterprise for Education
1320-A Santa Monica Mall, #202
Santa Monica, California 90401
(213) 394-9864

Cost: In-service training and materials are free in funded areas including PG&E, SMUD, Southern California Edison and Los Angeles Department of Water & Power. Otherwise, classroom sets for 22 are $7.21 or $11.15, depending on the number of pages in the booklet. Contact the publisher directly for more information.

These relatively new "skill builders" extract elements from the Energy '80 materials. Primarily dealing with fossil fuels and electricity, each skill builder is quite specific and works well to supplement existing curricula. Each full-color booklet is accompanied by a short quiz and teacher's guide. A brief description of each follows:

Energy Transformations (8 pages, Physical Science): Explores conversions by having students make a lightbulb and build an electric motor.

Working with Energy Graphs (8 pages, Math and Science): By interpreting bar charts, students date major energy eras (wood, coal and petroleum). Untangling a "spaghetti" flow chat shows kids where we get the energy we use and allows them to rank each source.

Sources of Electricity (16 pages, Science or Social Studies): A dilemma adventure where students review the pros and cons of nine sources. Develops cooperative learning skills and explores the scientific method.

Demand for Electricity (16 pages, Physical Science): The "Appliance Hunt" provides data collection and graphing opportunities in the student's home. Introduces amps, volts, watts and meter reading.

Efficiency of Electric Appliances (8 pages, Physical Science): Students measure the efficiency of an electric hot plate, then calculate the money savings from shifting to fluorescent light from incandescent. Energy guide labels are the concluding activity.

Generating Electricity (8 pages, Physical Science): Mini-discovery activities parallel the research of Oersted and Faraday, in changing mechanical energy into electrical energy.

The Once & Future King (8 pages, Earth Sciences): Explains fission and radioactive decay. A cardboard box and kernels of popcorn make half-life come alive. The lessons are filled with chances to collect, graph and analyze data from "peanutium" and "ice creamium".

Nuclear Fuel Cycle (8 pages, Physical Science): From mining uranium to operating a reactor and storing radioactive wastes. Detailed drawings of a nuclear power plant make it a good activity before field trip.

Nuclear Reactor (16 pages, Physical Science): How the nuclear reactor is built and operated. Half of the material covers how energy is locked in the atom and released during fission.

Geology of Oil (16 pages, Physical Science): Description of how organic material which gets into the sedimentary rock cycle becomes a usable fuel.

Refining Oil (16, pages, Chemistry): Demonstrations showing how the physical and chemical changes in a refinery convert crude oil into usable products.

Oops! We're Running Out

Imagine that all the electricity in your part of the country comes from only one source, an electric generating station near the bottom of a large dam. In the station the falling water turns a wheel, called a turbine, that turns an electric generator.

But there is a problem. Each year there are more people living in your part of the country . . . and the average person uses more electricity than he or she did the year before. Demand for electricity is growing. Engineers and economists are predicting that in seven to ten years people in your region will want more electricity than the generating station can make. To avoid running short and having **brownouts and blackouts**, a new source of electricity will have to be found. But what new source, and where will it come from? This is your **Dilemma.** How will you solve it?

Dilemma
What new source should we use?
Where will it come from?
What do we need to know so that we will choose the right source?

How to Solve a Problem
First, you need a clear idea of what your problem is. Then you need to know as much as you can to help you think of solutions and to decide which is *your* best solution.

Science gives us a way of knowing. In science we try to find best solutions by **Exploring,** then by trying to **Explain,** and then by **Testing** our explanation. The explanation that best fits the facts is the best solution.

You can use this booklet and your classmates' help to find your best solution to this electricity dilemma. You will find your best solution by **Exploring, Explaining,** and **Testing.** Start with your **Dilemma** (you're running out of electricity).

Explore:
Take a quick first look for information in this booklet.

Explain:
Try to come up with some "first thought" answers to the "Dilemma Questions" above. Use information in this booklet and talk with people as your teacher suggests.

Test:
Read carefully, discuss, listen, and think carefully. How well do your "first thought" answers fit the information in the booklet? Use all the information you have to help you decide if one source is your best solution to the problem. That solution, or an improved idea, will be your conclusion.

Conclusion:
The solution you choose as best after testing won't be a "right or wrong" answer. (In many situations there are no right or wrong answers.) But it is likely to be a better solution than the solution picked by someone who is not as well informed as you. You'll also be able to explain why you chose your best solution.

Table of Contents

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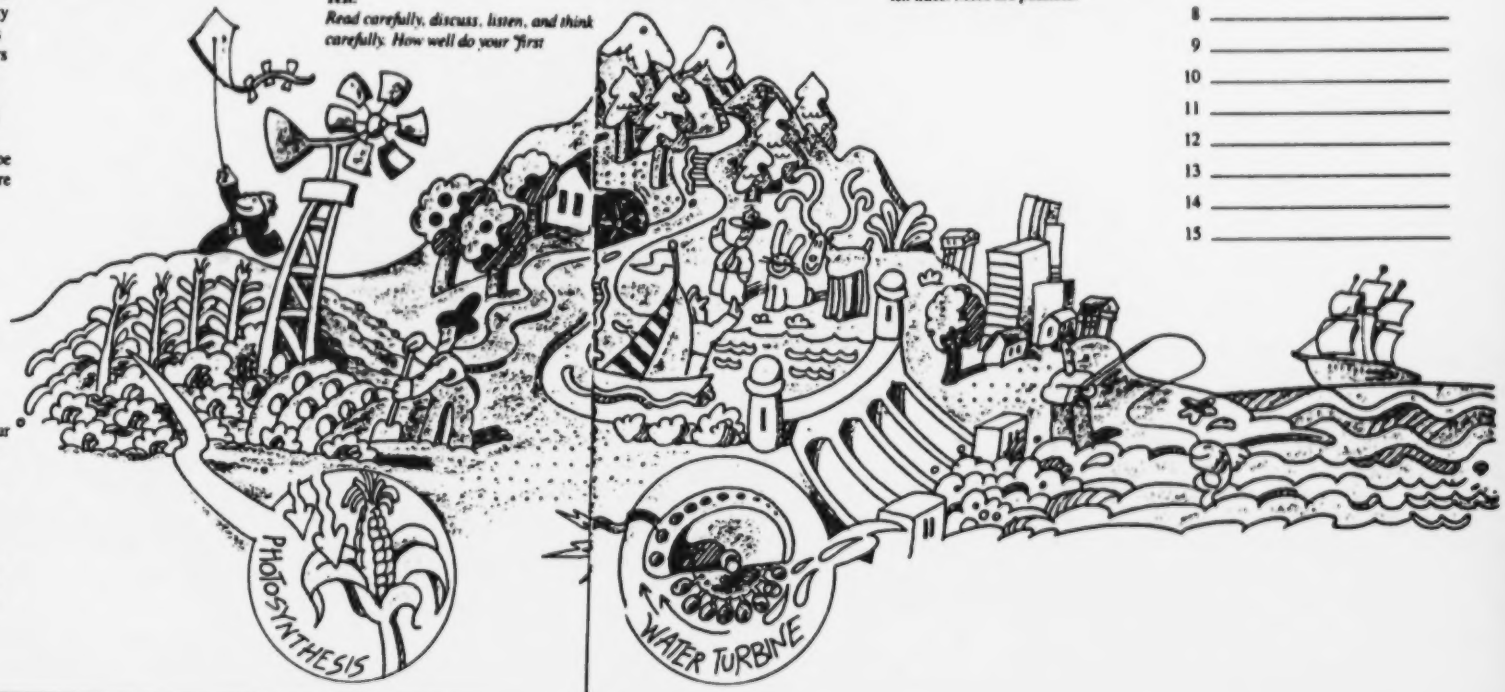


EXPLORING ENERGY: Sources/Applications/Alternatives
Basic energy text book

Grades: 7 through 12

Available From:
Goodheart-Willcox Company, Inc
123 West Taft Drive
South Holland, Illinois 60473
(312) 333-7200

Cost: $12.75

This 300-page basic text, written in 1985, is intended for courses on energy and is used as such at Sunset High School in Hayward, California. The basic physical principles of energy are explained using clear, simple language and hundreds of illustrations and pictures. It explains the basics of energy and how energy is extracted, processed and converted and introduces fossil fuels. Five chapters address alternatives such as solar, biomass, wind, hydro, geothermal and nuclear. Special chapters deal with the reality of a coming energy crunch, the need for conservation and the impact of energy on careers. Although the section on careers is chapter 14, one would hope that it is not left out due to time constraints. Many of the jobs are traditional and related to fossil fuels— exploration, extraction, refining, etc., although jobs in solar, biomass, and hydro are discussed, too. Each chapter includes a list of words to know, test questions and suggested outside activities. The teacher's guide includes drawings and directions for alternate energy and conservation projects and experiments.

Fig. 3-19. Load is the useful output of any power system. It is what is moved or changed. Bicycle's load is the weight of the rider and the weight of the bicycle itself.

MEASURING WORK

Work is measured in foot-pounds for conventional U.S. measure. A foot-pound is the amount of force necessary to move a 1 lb. load a distance of one foot.

The mathematical formula is:

WORK = DISTANCE × FORCE or
$W = D \times F$

To see how this formula works, suppose that the weight of the rider of a bicycle is 150 lb. How much work is done if the bicycle is pedaled 500 ft.?
$W = D \times F$
$W = 500 \times 150$
$W = 75{,}000$ ft.-lb.

In SI metric, which is being adopted by most countries, work is measured in joules. The unit is named after James Prescott Joule, an English scientist. The joule (J) is the work done when a force of 1 newton moves an object 1 meter. The formula is:

Work = Distance (in meters)
× Force (in newtons)

One newton is the force used to accelerate 1 kilogram of mass to 1 meter per second squared.

How many joules of work are done when a force of 300 newtons (N) is applied for a distance of 150 meters?

Using the formula:

$W = 150 \times 300 = 45{,}000$ joules

POWER

Work and power are often confused. Power is used when work is meant and vice versa. It is easier to separate them if you only remember that work does not concern itself with how long it takes. Only distance and force matter.

Power is the amount of work done in a given amount of time.

To measure power we use the following formula:

$$\text{Power} = \frac{\text{work}}{\text{time}} \text{ or } P = \frac{W}{t}$$

It can also be written:

$$P = \frac{D \times F}{t}$$

If a rider and bicycle weighing 150 lb. travel 500 ft. in 20 seconds, how much power is developed?

$$P = \frac{D \times F}{t}$$

$$P = \frac{500 \times 150}{20} = \frac{75{,}000}{20}$$

$= 3750$ lb.-ft. per sec.

PAPER CUP SCIENCE
Science experiments

Grades: 7 through 9 (Science)

Available from:
PG&E in their service territory and
California Energy Extension Service
1400 Tenth Street, Room 209
Sacramento, California 95814
(916) 323-4388

Cost: Free, one per request

An interesting and clever collection of 40 simple science experiments using inexpensive and easy to obtain materials. Paper cups are substituted for more expensive and cumbersome equipment. The authors encourage teachers to use basic hands-on teaching methods because "the hand that holds the equipment learns more than the hand that holds itself". The authors observe that after class, students can be seen in the lunch area performing experiments for their friends using paper cups just drained of juice. Experiments are divided into twelve topics including light, plants, pressure, sound, heat, molecular change, bonds, chemical reactions, matter, motion, inertia and gravity, with most of the experiments on the first five. The presentation is not fancy or slick, , just "materials needed," "procedure" and "thought questions" with a few simple drawings here and there.

HEAT IS A FACTOR OF COMBUSTION

Materials Needed:

1) Unwaxed paper cup
2) Cup holder
3) Heat source (Bunsen burner, alcohol lamp)

Procedures:

1) Fill cup 3/4 full of hot water (hot water cuts down time involved).
2) Hold cup with tong directly over flame until water boils (bottom rim will ignite and burn briefly).

Thought Questions:

1) Why did bottom rim ignite?
2) Why did it not continue to burn?
3) What kept the cup from burning?
4) What evidence was there that heat is necessary for combustion?
5) What evidence do we have that the heat applied to the cup was conducted away from the paper?

THOMAS ALVA EDISON EXPERIMENT BOOKLETS
Experiments

Grades: 4 through 9 (Science)

Available From:
Southern California Edison
Pacific Gas & Electric
Los Angeles Department of Water & Power

Cost: One copy free from utility

For Further Information:
Thomas Alva Edison Foundation
21000 West Ten Mile Road
Southfield, Michigan 48075

These small format, 32-page booklets, produced in the early 1970's by the Thomas Alva Edison Foundation contain easy, inexpensive experiments that illustrate scientific concepts for a variety of energy sources, including alternate energy sources such as tidal, geothermal, biomass, etc. Background information is presented to give the 5 to 10 experiments some context. One of the booklets focuses on Lewis Howard Latimer, a black inventor.

Topics of booklets include:
Magnetism and Electricity
Energy of the Future— How to investigate and reduce waste at home.
Alternative Energy— Sun, wind, geothermal, ocean, tidal, coal, garbage, chemicals.
Electrical and Chemical
Environmental Problems-- Experiments related to the effects of pollution.
Lewis Howard Latimer: A Black Inventor— Parallel circuits, burglar alarms and others.
Thomas Alva Edison: Selected Experiments and Projects— Related to his 1,093 inventions including the phonograph, motion picture camera and lightbulb.
Nuclear (for high school): Building a geiger-counter is featured.
Energy Conservation— How energy can be conserved immediately including storm windows, clothes dryers and refrigerators.

with pencil and paper in hand — and see how well the lights in your home stack up. Tell your parents about your findings.

• Are bulbs and lampshades free of dust and dirt that block light transmission? Dirty bulbs and shades waste the light produced inside the bulbs. As a result, you may turn on two lights when only one is really necessary.

• Are lampshades *translucent* (so light can pass through them) rather than solid? It doesn't make sense to use energy to produce light, and then block the light with a solid lampshade.

• Are ceilings and walls light-colored? Light colors reflect more light than dark colors, and so fewer lamps (or lower-wattage bulbs) can be used to light the room.

• Are "non-critical" lighting levels in your home kept as low as possible? As a rule of thumb, one watt of lighting per square foot of floor area is adequate for general room and hallway lighting. Use your yardstick or tape measure to make measurements. Of course, "critical" tasks (such as reading, sewing, building model airplanes, and doing your homework) require more light.

• Does every member of your family turn off lights after he or she leaves a room? Not doing this is just as out-and-out waste of valuable energy!

By the way, you may hear some people say that they *purposely* leave lights on. These people mistakenly believe that the sudden surge of electricity that flows through a light bulb when it is turned on represents a lot of energy. They think that keeping the bulb lit — and thereby avoiding starting surges — somehow saves energy.

They are wrong! A light bulb consumes less energy during its starting surge than during a *single second* of normal operation.

Always turn lights off when they are unnecessary, even for a few seconds.

EXPERIMENT 10:
CHECKLIST FOR ENERGY — EFFICIENT LIGHTING

THINGS YOU NEED: A yardstick or tape measure.
Pencil and paper.

How much energy is used to light your home? Probably, about 2000 kilowatt-hours of electrical energy each year. Your local electric power plant burns about 150 gallons of oil (or over ½ ton of coal) to generate the electricity.

With this much energy "going up in light," it makes good sense to learn to use lighting efficiently. This simple lighting checklist will give you a head start. Walk through your home -

ENERGY IN AMERICAN HISTORY
Part of the Energy Source Program
Self-contained curriculum kit

Grades: 7 through 9 (Social Studies)

Available From:
San Diego Gas & Electric
Southern California Gas
Modesto Irrigation District

Cost: Free from many utilities

For Further Information:
E D S
5505 East Carson, Suite 250
Lakewood, California 90713
(213) 420-6814

The overall goal of the Energy in American History unit is to help junior high school students understand how energy has shaped American history. Dr. Viola Strangeways and Rex, her timewarp capsule and computer, travel back in time, beginning with the colonial period. They talk with inventors and look at how energy has changed the way Americans live. Trends and factors causing the rise and fall of major fuel eras are identified along with factors relating to the present energy crunch. The 15 lesson unit is divided into three parts and takes about two weeks to complete. It includes teacher guide, student booklets, three filmstrips and cassette tapes, poster of energy eras, pre- and post-tests, and home information booklets. It correlates well with work on the Industrial Revolution and 20th Century.

Memo From The Fifties

TO: Teenagers of the '80s
FROM: Bill "Skids" Wimberly

Hi, gang. My name's Skids Wimberly. They call me "Skids" because I never have all four wheels on the ground when I go around a corner. Anyway, I just want to tell you a little about what it was like growing up in the 1950s.

Now I know you think you've got it pretty rough, but let me tell you . . . things in my day were different. You've got it easier in a lot of ways. Take your basic record player. In the '50s, no one had stereos. We had little one-speaker record players and 45 r.p.m. records. Some of the lucky kids had hi fi's, but usually they belonged to their parents. Believe me, parents weren't too hip to playing "Rock Around the Clock" or "Jailhouse Rock" on them, either.

Speaking of parents . . . their lives were different, too. For example, my mom and dad both worked in offices. In those days, more things were done by manual machines. Typewriters weren't electric and neither were calculators. In 1956, when I was fourteen, my dad's office got its first computer. Before then, things took a lot longer to do. That computer really changed my dad's work. After they got it, he could spend a lot less time at things which used to fill up most of his workday.

Another thing is television. When I was ten years old, my family didn't have a television. Not many did. We spent a lot of time listening to the radio, instead. Radio was O.K., but television was a lot more interesting. You could see as well as hear. I guess the day my mom and dad brought home our first TV set was one of the most exciting times I can remember. It sure changed the way we lived at our house.

Come to think of it, many things were different in a '50s house than they are today. Take the kitchen, for example. We didn't have electric can openers, trash compacters, microwave ovens, electric knives, toaster ovens, or a lot of the items that you find in a kitchen of the '80s. The bathroom was different, too. No electric toothbrushes, modern blow dryers, or Waterpics in a '50s bathroom.

Long distance travel was different, too. I remember going back East to visit relatives one summer. I flew on a big propeller-driven Constellation airliner. The trip took nearly nine hours. Jet planes make the trip in about one-third that time. No stops for refueling, either. Flying today is more comfortable and faster.

Well, enough is enough. I don't want you kids to flip out. Just remember that even though you've got it easier, you use a lot more energy than we did. Maybe that's why they used to call us the "cool" generation. Hey, no offense, I think you guys are real cool, too. Well, like we used to say in the fifties, I've got to peel out now. See ya later, alligator.

ELECTRIC GNUS
Part of the Energina Program
Interdisciplinary unit

Grades: 7 through 9

Available From:
Los Angeles Department of Water & Power
Pacific Gas & Electric
Sacramento Municipal Utility District
Southern California Edison
Many municipal utilities

For Further Information:
Innovative Communications
207 Coggins Drive
Pleasant Hills, California 94523
(415) 944-0923

The 16-page, full color, comic workbook lures students into fact filled, problem-solving activities in math, science and social science by reminding them that energy can be fun, but is no joke. The title, "Electric Gnus", gives a flavor for the "punny" humor. By reading a take-off on the National Inquirer, energy horoscopes, battle of celebrity statistics, etc., students learn about energy supply and demand, limited resources, alternatives and their potential, load management and conservation. This is one of the few booklets that has students apply their knowledge to reducing energy at school and can be used in conjunction with CEES materials on the Energy Patrol and How to Organize and Communicate your Energy Data. The kit comes with a 40-page teachers guide that provides easy-to -use teaching guidelines for implementing the 3, 5, or 10-day unit, although it can easily be infused into existing curriculum with little or no teacher preparation. The guide has a good list of resources, spin-off activities, reproducible items, glossary and bibliography.

WOOFMAN JACK ***(Science)***

Music hath charm to lure the average adolescent, or something. . .Anyway, believe it or not we had a science activity in mind when we created this punny (puny) potpourri. Using the same format of song title and name of "artists," assign your students the task of composing a hit list of all of the alternative energy sources mentioned in both the "Gnational Gnose" and "Escape from the Bermuda Triangle." The artists should be an expansion of the theme of the song, and show that the student has some grasp of the nature of the source. Next, divide the class into groups, and have each group write a verse and a chorus which is descripeve of one alternative source, assigned by you. Finally. . .you guessed it, have each group perform their composition for the rest of the class, followed by a class discussion of the advantages of the alternative sources.

1. **Double Date on a Pair of Skates,** by Odd Day and the Even Plates
2. **Better and Better,** by the Weatherstrippers
3. **Afternoon Blackout,** by Otis Overloader
4. **Empty Tank Blues,** by Leadfoot and the Daytrippers
5. **One Miracle Short,** by Wendy and the Wasters
6. **Use Me Wisely,** by Charlie Watts
7. **The Longest Line,** by Regulata and the Old Fuels
8. **I Don't Care to Share,** by Conspicuous Consumption

- Research how much "juice" is required to power a rock band, including instruments, amplifiers, etc. Compare this to other energy uses in the home.

JEAN NIXON ***(Social Science)***

Who can foretell what might happen when you have small groups of students take different sections of the horoscope, and using their own astrological signs, develop themes for class presentations? These offerings could be done in the form of skits, demonstrations, radio/TV commercials, debates, charades, etc. Following each presentation, have the groups prepared to answer questions or lead discussions on their topics. Complete the activity by giving a quiz using questions submitted by each group on their topic.

CAPRICORN (Dec. 22-Jan. 19) — Education is the keynote in your life. Learn how to read your electric and gas meters and you'll be rewarded by saving energy . . . and money.

AQUARIUS (Jan. 20-Feb. 18) — Express yourself as an individual and a trendsetter. Wear a sweater around the house and turn your thermostat down to 68° or less in the winter and you'll attract the attention of "those in the know."

PISCES (Feb. 19-March 20) — Be a radiant example today and let the sun shine in. Solar power can bring you heat and light right through the window—and savings on your electric and gas bills.

CANCER (June 21-July 22) — Break from the past and get out of a rut. Look for new ways to save energy, like setting the air conditioner thermostat at 78° or above.

LEO (July 23-Aug. 22) — A startling idea will come to you. You should shift some electrical usage away from periods of peak demand, such as noon to 6:00 PM, to the morning or evening. Now you're doing your bit for load management.

VIRGO (Aug. 23-Sept. 22) — Now is the hour to pay attention to details in your life. Make your dental check-up appointment, pay your debts, and replace your air conditioner filter—it will run more efficiently.

ENERGY CHOICES & CHALLENGES
Part of the Energy Source Program
Self-contained curriculum kit

Grades: High school Social Science or Science

Available From:
Several utility companies in Southern California

Cost: Free from many utilities

For Further Information:
E D S
5505 East Carson, Suite 250
Lakewood, California 90713
(213) 420-6814

The Energy Choices and Challenges unit deals with facts about our current energy situation and with critical issues that confront our nation. The unit, originally developed in 1983, has been revised and will be available in early 1988. Social, technological, political, economic and environmental issues are a major focus of the unit and presented in a glossy, 48 page handbook containing articles on energy history after the 1973 oil embargo, fossil fuels, alternative energy, electricity and conservation. New topics such as oil prices, superconductors, Chernobyl, fuel switching and utility ratemaking have been added. The Energy Issues section now stands alone as a 12 page booklet and explores viewpoints on seven energy issues including offshore oil, deregulation of natural gas, acid rain, nuclear waste disposal, low income energy use, energy independence and regulation.. The unit can be conducted in eleven to fourteen class periods and contains teacher guide, student booklets, two audio-visual programs, poster and pre and post-tests. The new teacher guide presents discussion questions, answer keys and activities making it easier for teachers to work the unit into on-going curriculum.

Energy for the Needy

High energy prices present special problems for low-income customers. Several programs have been proposed to help these people, many of them elderly, with their utility bills.

If you live in this country, do you automatically have the right to be warm when it's freezing outside?

As energy costs rise, Americans are having to face this question more and more. For example, the Citizen-Labor Energy Coalition, a consumer group, estimated that 240,000 households had their natural gas cut off during a recent winter because of unpaid bills. And this estimate covered only natural gas, not households heated with fuel oil or electricity.

Rising energy costs are a special problem for the elderly. Northern States Power Company (NSP), a utility based in chilly Minnesota, reports that nearly one in every three of its customers over age 60 is low-income. The elderly comprise 60 percent of NSP's low-income customers. Commenting on the national situation, Richard Chamberlain of the Salvation Army says, "It's not so much paying the bills — shut-off notices are few — but the elderly are going without nutrition to pay their utility bills."[1] Another group that has been hard hit are the "new needy" — people who have suddenly lost their jobs and cannot find work because of tight economic conditions.

To deal with the problem, utility companies are committing millions of dollars of their own money and soliciting additional help from the public. Around the country a growing number of programs are springing up. A few examples:

Many utilities remind customers on their monthly bills that they can voluntarily pay extra, with the added dollars going for the needy.

In addition to their other assistance programs, several utilities contribute a dollar or two for each dollar donated by their customers.

A northern utility has proposed a plan to its state public utilities commission that would give a 25 percent discount to its low-income ratepayers. The utility estimates that this program would cost its other ratepayers less than $5 a year. The same company will not cut off a low-income customer's gas or power during the cold-weather period of October 15 to April 15 if the customer works out an approved payment schedule for overdue utility bills.

A midwestern utility sells $5 to $100 "I Care" gift certificates that can be given to the needy.[2]

The federal government is helping too. Its federal energy assistance program returns nearly $2 billion in energy grants to the states. Traditionally these funds have been used mainly to help the needy pay heating bills. Now energy officials in some states are using part of the money to help low-income families make improvements that upgrade the energy efficiency of their homes.

Still, all these funds are not nearly adequate to solve the problem. Under many programs the available money is only enough to provide a fixed amount of help, such as $100 to $200 for the entire winter season. Heating bills for a single winter month often run much higher than that in colder areas of the country.

"This is a problem that won't go away by itself," emphasizes Richard Stanford of Northern States Power. "We've got to deal with it in a better way than we are now."

Discussion Questions

1. What do you think should be done so that low-income Americans get the energy they need? Select an answer from the choices below or come up with your own.
   a. The federal government should use tax money to pay for it.
   b. Utilities should request rate increases from their public utilities commissions and use the extra money to pay the utility bills of their low-income customers.
   c. We should do what we can on a voluntary basis but not require anyone to pay extra just for the benefit of others.
   d. Nothing. Low-income people should deal with the problem themselves.
   e. Other. (Give an answer of your own that you think is better than any of the above.)
2. Suppose that you were in charge of a state program to provide energy assistance to the needy. For which purpose would you spend more money: payments to help low-income persons pay their energy bills or payments to help them make their homes more energy efficient? Why?

POLITICS OF ENERGY
Part of the Energina program
Simulation game

Grades: 11 and 12 (Government)

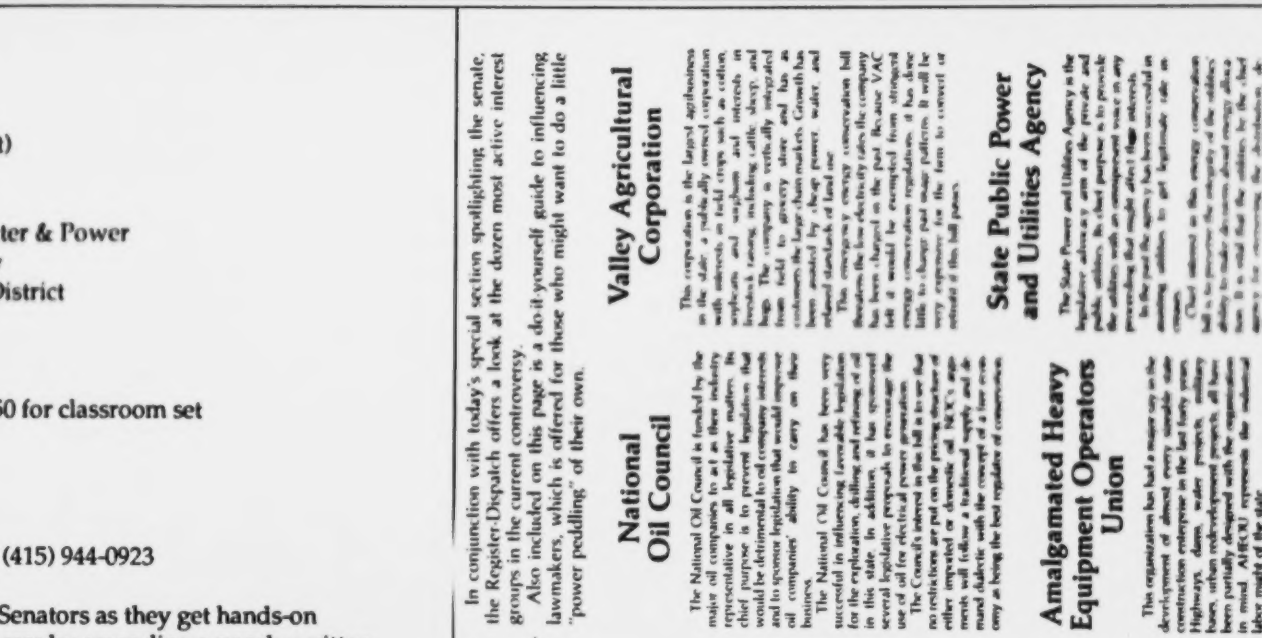
Available From:
Los Angeles Department of Water & Power
Pacific Gas & Electric Company
Sacramento Municipal Utility District
Southern California Edison
Many municipal utilities

Cost: Free from utilities or $49.50 for classroom set

For Further Information:
Innovative Communications
Post Office Box 23205
Pleasant Hill, California 94523, (415) 944-0923

Students become lobbyists and Senators as they get hands-on experience in the legislative process by amending a poorly written bill to reduce energy consumption by 20%. For role playing, students consult the "Register Dispatch" newspaper that sets the scene and gives descriptions of characters. To help them understand the issues, a journal of energy articles and a computer data base are provided. (Although the data is a few years old, this does not hamper the activity as it focuses more on the legislative process than energy information. Teachers may also decide to have students update information as a research activity.)

The unit is complete with all the materials needed to conduct the simulation— newspaper, senate bill, energy journal, computer printouts of data and a 48-page teachers guide including learning objectives, teaching strategies, schedule, and debriefing. Although the simulation takes a considerable amount of time to get going, this is compensated for because the unit can sustain itself with little teacher input for up to three weeks. An implementation kit is sold separately that provides an overview and a day-by-day discussion walking the teacher through the entire activity.



In conjunction with today's special section spotlighting the senate, the Register-Dispatch offers a look at the dozen most active interest groups in the current controversy.

Also included on this page is a do-it-yourself guide to influencing lawmakers, which is offered for those who might want to do a little "power peddling" of their own.

Valley Agricultural Corporation

This corporation is the largest agribusiness in the state a publically owned corporation with interests in field crops such as cotton, soybeans and soghum and interests in livestock raising, including cattle sheep and hogs. The company is vertically integrated from field to grocery store and has an endowment the largest chain markets. Growth has been assisted by cheap power, water, and relaxed standards of land use.

The emergency energy conservation bill threatens the low electricity rates the company has been charged in the past. Because VAC left it would be exempted from stringent energy conservation regulations. It has done little to change past usage patterns. It will be very expensive for the firm to convert or remodel if this bill passes.

National Oil Council

The National Oil Council is funded by the major oil companies to act as their industry representative in all legislative matters. Its chief purpose is to prevent legislation that would be detrimental to oil company interests and to sponsor legislation that would improve oil companies' ability to carry on their business.

The National Oil Council has been very successful in influencing favorable legislation for the exploration, drilling and refining of oil in this state. In addition, it has sponsored several legislative proposals to encourage the use of oil for electrical power generation.

The Council's interest in this bill is to see that no restrictions are put on the pricing structure of either imported or domestic oil. NOC's arguments will follow a traditional supply and demand dialectic with the concept of a free economy as being the best regulator of commerce.

State Public Power and Utilities Agency

The State Power and Utilities Agency is the legislative advocacy arm of the private and public utilities. Its chief purpose is to provide the utilities with an unimpaired voice in any proceeding that might affect their interests.

In the past the agency has been successful in assisting utilities to get legislative relief on issues.

Chief interest in the energy conservation bill is to preserve the integrity of the utilities' ability to make decisions about energy plans. It is vital that the utilities be the chief agency for overseeing the distribution of energy and use of electric power.

Amalgamated Heavy Equipment Operators Union

This organization has had a major say in the development of almost every sizeable state construction enterprise in the last forty years. Highways, dams, water projects, public buses, urban redevelopment projects all have been partially designed with the organization in mind. AHEOU represents the unskilled labor might of the state.

The union's main interest in this bill is that jobs for members not be lost because of energy conservation laws. In fact the AHEOU believes that specific provisions should be added to this law that will prevent industry from laying off workers just to minimize energy

Association of Public Agency Representatives

The Association of Public Agency Representatives was founded with the purpose of unifying the presentation of the legitimate interests of state and local entities whose tasks are influenced by the passage of legislation. At times the organization has been most effective in changing regulatory or enabling legislation that would have destroyed some of the agencies that it represents.

This bill regarding energy conservation provides the organization two opportunities:

1. To help in the design of regulations that will be enforced by both local and state agencies.
2. To emphasize again, in public, the legitimacy and significance of public service employees, and the important contributions, both as workers and as providers of sound data, that public employees have made to energy conservation.

State Industrial and Manufacturers Consortium

The IMC represents the owners and managers of the state's largest manufacturers from steel and concrete to microelectronics. The organization is the voice of capital intensive industry. Much of its lobbying in the past has been aimed at maintaining a friendly and healthy climate for industry. The group is particularly concerned that the state continues its economic growth. The organization believes that industry has been responsible in developing energy efficiency and that other sections of the economy have not done their fair share.

IMC's main interest in this bill is to see that heavy industry is not hamperedby unreasonable conservation rules and regulations. The group is willing to work for the good of the state, but continued economic growth is essential

Retail Merchant's Association

This statewide organization has as its main purpose the preservation and encouragement of a healthy climate for retail business in the state. The members feel that in the past they have skillfully represented the state's retail interests regarding a reduced sales tax, a reduction in the number and kind of business taxes required and incentive programs to face energy use.

Regarding this piece of energy legislation, the group feels very strongly that retail merchants are already doing their fair share of energy reduction, but that incentives to do more are in line, without any penalties whatsoever.

Friends of Natural Wilderness

The Friends of Natural Wilderness began as a local group of ecologically minded citizens interested in preserving a local riverine environment that ran through their community. Today it is a national organization with lobbyists in every state fighting to preserve what is left of the natural environment. Through the sale of a wide assortment of books, slides, pamphlets and periodicals, the organization has amassed a considerable budget for buying or taking options on desirable wilderness areas.

The group's interest in this bill is based on the belief that "less is more," that a stable economy is more ecologically sound than a growing one. They believe that this bill should be made permanent and that economic incentives should be provided for every section of the economy to increase energy savings.

ELECTRICITY CHOICES
Energy activities

Grades: 7 through 9 (Science/Social Science)

Available From:
Los Angeles Department of Water & Power
Sacramento Municipal Utility District
Southern California Edison

Cost: Free in utility service territory

This series of five small format, 16-page booklets developed in 1984 for California utilities, present various options for generating electricity: Fuels that Burn (coal, oil and natural gas); Wind and Water (wind, hydro, geothermal and ocean); Solar (mostly thermal and photovoltaic); Nuclear and Power Management (conservation, load management and energy storage). For each booklet, a teacher's guide provides two science experiments which often rely on experiments from the Thomas Edison Foundation that the utilities also provide, a crossword puzzle featuring the vocabulary introduced, a glossary and additional social science and science strategies.

Although the booklets are small and the introductory material fairly brief, a number of diagrams and illustrations give an overview of the advantages and disadvantages of a number of sources, particularly those that are often difficult to find such as geothermal and ocean and tidal energy. It is also unique to see a booklet on energy management, although not surprising since it acknowledges the emphasis on management by California utilities as a "source" of energy. This is one of the few places to find an introduction to peak power usage and time-of-day pricing.

LOAD MANAGEMENT

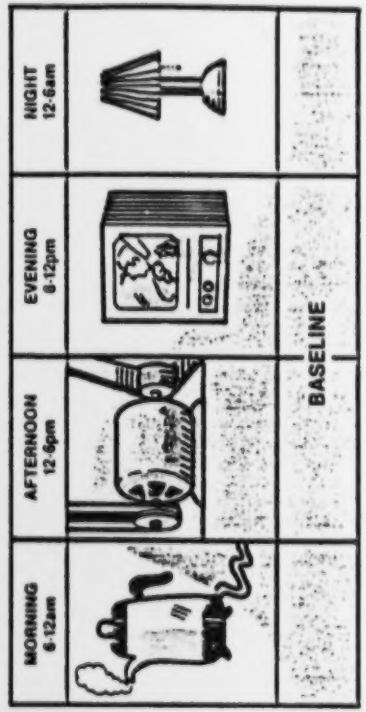
The use of electricity follows a pattern. The "peak" (highest) use of electricity is on weekday afternoons, when it is common for demand to be twice as high as during "off peak" hours (when consumption is low). Electrical use usually is lowest during early morning hours on weekends.

Electric utilities usually try to have systems which will supply the lowest demands with what is called "base-load power." This is power generated around-the-clock, using the most inexpensive source—usually hydroelectricity, coal or nuclear.

On an average day, as demands increase, additional generating equipment is used to provide more electricity, as needed. And finally, at the peak of the day's demand, last-step generating units are brought on line, supplying the final amounts of electricity needed.

The equipment used for supplying peak demands is usually the most expensive to operate. It often is a plant that burns the most costly fuel, such as oil or natural gas. Therefore, utilities try to avoid using these plants in order to keep costs down. One way to reduce the amount of high-cost electrical generation is by load management—shifting electrical load (or demand) from peak hours to other times of the day.

Efficient use of generating equipment through load management holds down costs, and helps reduce the need for using oil and gas as fuels to generate electricity. Energy planners believe that good load management will make us less dependent on oil and natural gas, and ease the nation's crunch.



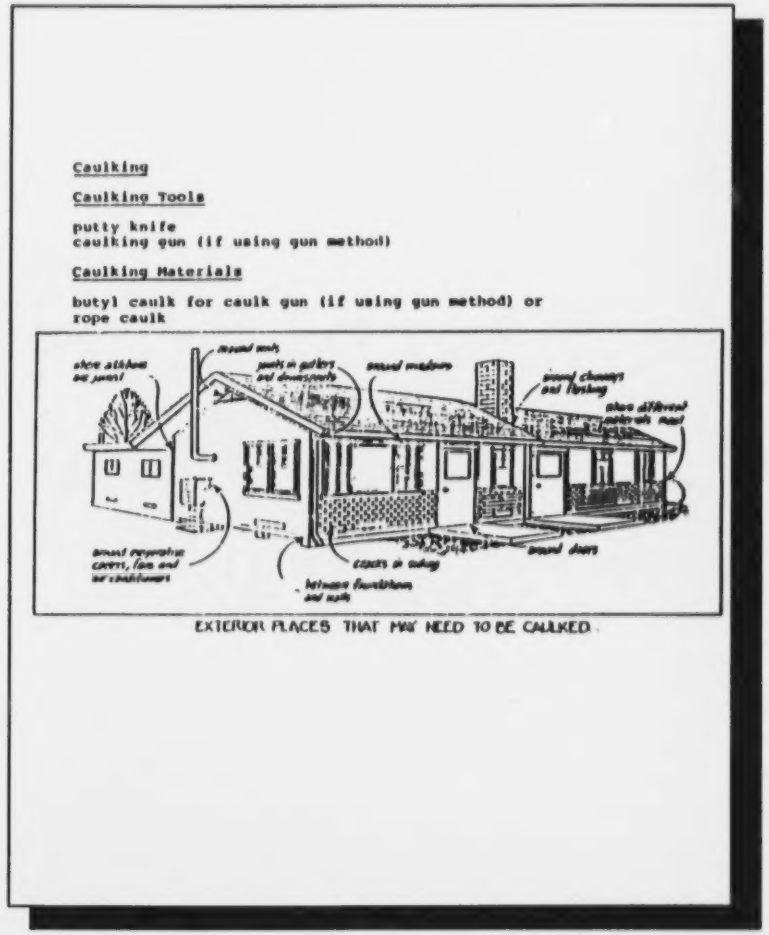
PRACTICAL ENERGY PROJECTS FOR INDUSTRIAL ARTS AND SCIENCE TEACHERS/STUDENTS
Building Plans

Grades: 10 through 12.

Available From:
California Energy Extension Service
1400 Tenth Street, Room 209
Sacramento, California 95814
[916] 323-4388

Cost: No charge for one [1] copy

This is a set of seven [7] plans for "hands-on" construction of energy projects developed by the Alternative Energy Collective in Berkeley. The projects are: a window greenbox; solar oven; weatherization; concentrating bread box solar water heater; passive solar waterheater; anemometer; and solar radiometer. The plans are clearly written for teachers and students to build as part of a school project. The projects are designed for installation.



EXTERIOR PLACES THAT MAY NEED TO BE CAULKED.

THE BALANCING ACT: HOW UTILITY RATES ARE DECIDED
Self-contained curriculum unit

Grades: 9 through 12 (Economics)

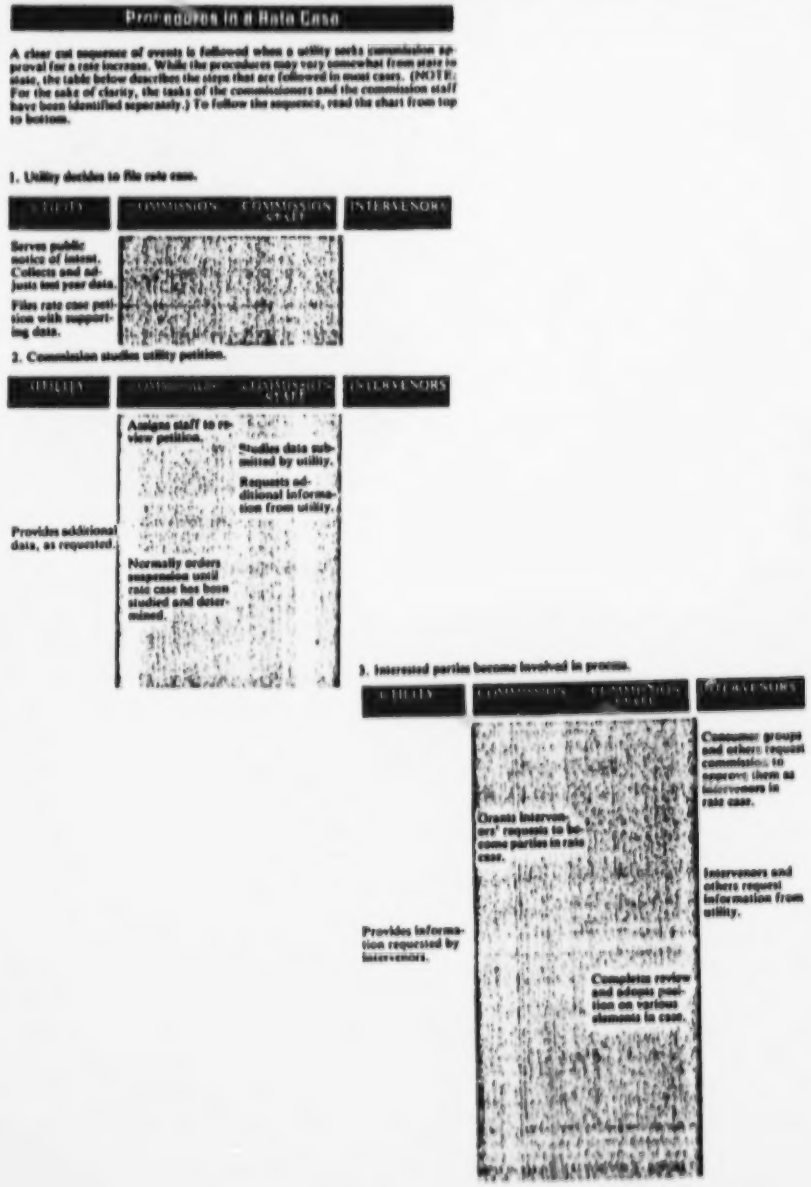
Available From:
Phyllis Blankenship
American Gas Association
1515 Wilson Drive
Arlington, Virginia 22209
(703) 841-8676

Cost: May be free from utilities

California utilities are in the process of working out distribution and teacher training. Contact Armando Navarro at Pacific Gas & Electric, (415) 972-0789.

Through simulation and role-playing, the unit teaches how utility rates are set, the parties involved in the process and their "special interests" and some of the deciding factors in establishing rates. In an imaginary rate case introduced to students through a videotape simulating a local newscast, a local utility is granted a rate increase for natural gas and the Public Utility Commission must decide how much of the increase each customer group will bear. Students research the issues and hold a mock hearing taking the roles of opposing groups— consumers, industry and local merchants.

The unit consists of student handbooks, a teacher's guide, reproducible worksheets, pre- and post-tests, a supplement comparing the generic materials with the California process and a 16-minute videotape that sets the scene and may be conducted in a two, three, or five-day format. The unit was field-tested in conjunction with the Center for Economic Education in 1987 in a variety of classrooms in Northern California. Pacific Gas & Electric is developing a matrix to correlate the unit with the state curriculum framework for economics and social studies.


Proceedings in a Rate Case
A clear cut sequence of events is followed when a utility seeks commission approval for a rate increase. While the procedures may vary somewhat from state to state, the table below describes the steps that are followed in most cases. (NOTE: For the sake of clarity, the tasks of the commissioners and the commission staff have been identified separately.) To follow the sequence, read the chart from top to bottom.
1. Utility decides to file rate case.
UTILITY
COMMISSION
COMMISSION STAFF
INTERVENORS
Serves public notice of intent. Collects and adjusts test year data.
Files rate case petition with supporting data.
2. Commission studies utility petition.
UTILITY
COMMISSION
COMMISSION STAFF
INTERVENORS
Assigns staff to review petition.
Studies data submitted by utility.
Requests additional information from utility.
Provides additional data, as requested.
Normally orders suspension until rate case has been studied and determined.
3. Interested parties become involved in process.
UTILITY
COMMISSION
COMMISSION STAFF
INTERVENORS
Consumer groups and others request commission to appear them as intervenors in rate case.
Grants intervenors' requests to become parties in rate case.
Intervenors and others request information from utility.
Provides information requested by intervenors.
Completes review and adopts position on various elements in case.

ENERNOMICS
Part of the Energina program
Self contained curriculum kit

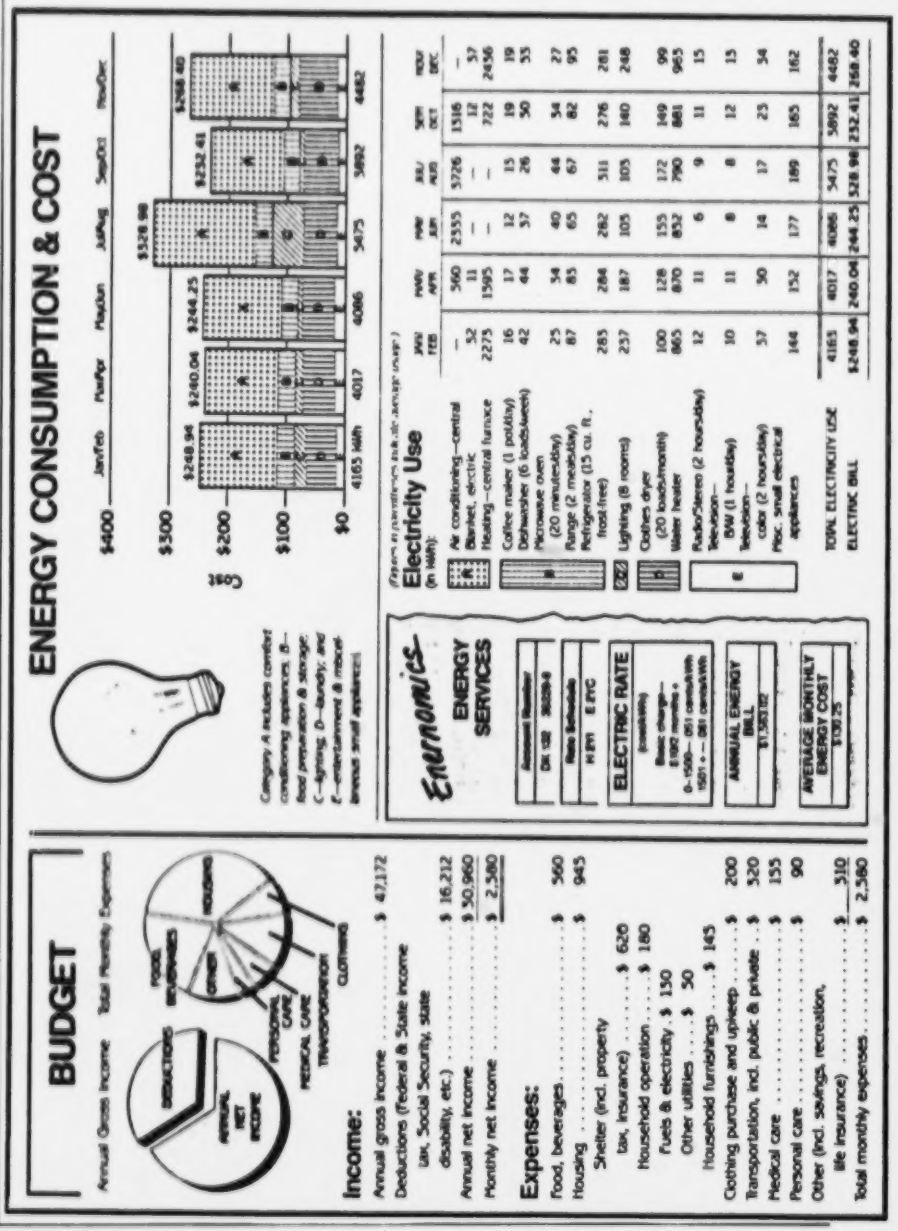
Grades: 9 through 12 (Economics)

Available From:
Pacific Gas & Electric
Sacramento Municipal Utility District
Southern California Edison
Many municipal utilities

Cost: Free from participating utilities or $59.60 for classroom set

For Further Information:
Innovative Communications
207 Coggins Drive
Pleasant Hills, California 94523
(415) 944-0923

This introductory unit for economics has a problem-solving focus on the home energy budget, but also develops student skills such as interpreting charts. The unit takes between four and ten days to implement and is presented to the teacher with four optional formats that accomodate a variety of teaching styles. Materials in the kit include a cartoon style booklet to introduce the concepts, the students, a filmstrip bridging the gap between economics concepts and the problem focus, a set of factsheets for eight households with different occupants, dwellings, habits, etc., a take-home energy audit and a tabloid with informative articles about saving energy.



HIDDEN COSTS OF ENERGY, THE OIL ROLLERCOASTER, and others
Supplemental materials

Grades 9 through 12

Available From:
Fund for Renewable Energy and the Environment
1001 Connecticut Avenue, NW, Suite 638
Washington, DC 20036
(202) 466-6880

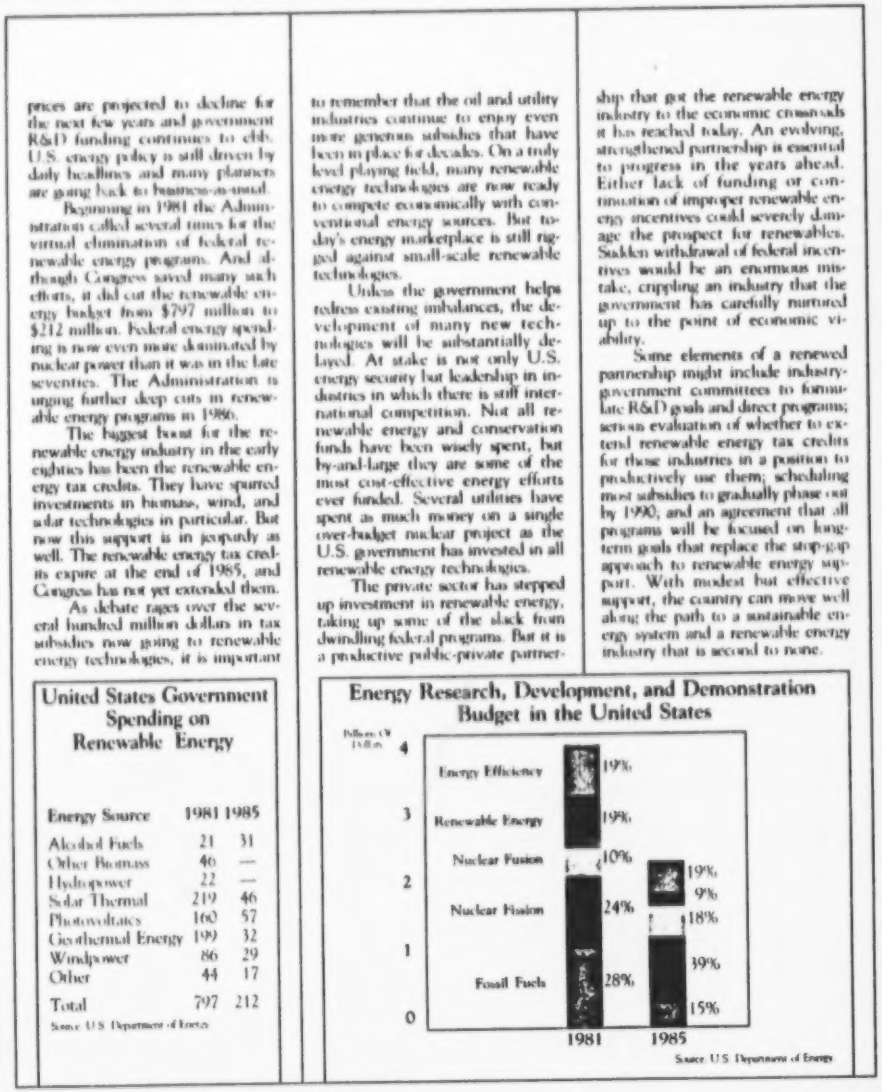
Cost: Single copies $4.00 (bulk rates available)

The Fund for Renewable Energy and the Environment publishes a series of educational booklets full of facts that provide another perspective for looking at energy policy and decision-making in this country. They make an important contribution to public dialogue about vital issues. The authors vary with each publication, but typically are Washington-based policy analysts and organizations.

In the *Hidden Costs of Energy*, December 1986, the authors state that an equivalent of $523 in tax dollars for every household in the United States was to subsidize energy producers. The book goes on to explore the oil glut, U. S. position in the world market, the coming energy crisis, alternatives for a transition from oil and the politics of energy. Lots of charts and graphs are included which are easy to use for math activities.

The *Oil Rollercoaster*, was co-authored by Chris Flavin of the WorldWatch Institute, Dennis Hayes from FREE and Jim MacKenzie of World Resources Institute in response to the Department of Energy's report on energy security. Both reports note the threat of another energy crisis with increasing reliance on foreign oil, but offer different emphasis in the policy recommendations.

Others in the series published in 1985 include *Renewable Energy at the Crossroads*, a 24-page report by Chris Flavin and *Electricity: New Consumer Choices* by Dick Munson which looks at tomorrow's options for the electric utility industry.



prices are projected to decline for the next few years and government R&D funding continues to ebb. U.S. energy policy is still driven by daily headlines and many planners are going back to business-as-usual.

Beginning in 1981 the Administration called several times for the virtual elimination of federal renewable energy programs. And although Congress saved many such efforts, it did cut the renewable energy budget from $797 million to $212 million. Federal energy spending is now even more dominated by nuclear power than it was in the late seventies. The Administration is urging further deep cuts in renewable energy programs in 1986.

The biggest boost for the renewable energy industry in the early eighties has been the renewable energy tax credits. They have spurred investments in biomass, wind, and solar technologies in particular. But now this support is in jeopardy as well. The renewable energy tax credits expire at the end of 1985, and Congress has not yet extended them.

As debate rages over the several hundred million dollars in tax subsidies now going to renewable energy technologies, it is important to remember that the oil and utility industries continue to enjoy even more generous subsidies that have been in place for decades. On a truly level playing field, many renewable energy technologies are now ready to compete economically with conventional energy sources. But today's energy marketplace is still rigged against small-scale renewable technologies.

Unless the government helps redress existing imbalances, the development of many new technologies will be substantially delayed. At stake is not only U.S. energy security but leadership in industries in which there is still international competition. Not all renewable energy and conservation funds have been wisely spent, but by-and-large they are some of the most cost-effective energy efforts ever funded. Several utilities have spent as much money on a single over-budget nuclear project as the U.S. government has invested in all renewable energy technologies.

The private sector has stepped up investment in renewable energy, taking up some of the slack from dwindling federal programs. But it is a productive public-private partnership that got the renewable energy industry to the economic crossroads it has reached today. An evolving, strengthened partnership is essential to progress in the years ahead. Either lack of funding or continuation of improper renewable energy incentives could severely damage the prospect for renewables. Sudden withdrawal of federal incentives would be an enormous mistake, crippling an industry that the government has carefully nurtured up to the point of economic viability.

Some elements of a renewed partnership might include industry-government committees to formulate R&D goals and direct programs; serious evaluation of whether to extend renewable energy tax credits for those industries in a position to productively use them; scheduling most subsidies to gradually phase out by 1990; and an agreement that all programs will be focused on long-term goals that replace the stop-gap approach to renewable energy support. With modest but effective support, the country can move well along the path to a sustainable energy system and a renewable energy industry that is second to none.

United States Government Spending on Renewable Energy

Energy Source	1981	1985
Alcohol Fuels	21	31
Other Biomass	46	—
Hydropower	22	—
Solar Thermal	219	46
Photovoltaics	160	57
Geothermal Energy	199	32
Windpower	86	29
Other	44	17
Total	797	212

Source: U.S. Department of Energy

Energy Research, Development, and Demonstration Budget in the United States

Source: U.S. Department of Energy

NATIONAL ENERGY EDUCATION DAY PROJECT
Supplemental activities

Grades: 7 through 12, although some for upper elementary

Available From:
California Energy Extension Service
1400 Tenth Street, Room 209
Sacramento, California 95814
(916) 323-4388
or
The NEED Project
1900 Association Drive
Reston, Virginia 22901

Cost: $10 for schools and $25 for non-schools (Carnival is $7.95)

The National Energy Education Project (NEED) was founded in 1980 with a Joint Congressional Resolution that prompted schools through the country to develop energy education programs. NEED combines hands-on experiences, competition and fun to teach students about energy and develop their leadership skills. The emphasis on leadership training encourages students who might otherwise not care about energy education to become involved. One of the strengths of the program is that students are responsible for determining their own level of participation and learning. The format appeals to service groups such as Key or S Clubs, student government, 4-H and Science or Ecology clubs, because it provides ideas for community involvement and fund raising projects. Schools are encouraged to "put it all together" and compete for an all-expense paid trip to Washington, DC.

Schools receive a booklet of resources, organizational hints, an energy poll, an energy play, 16 successful projects including energy rock videos, "Let's Talk Energy Show" and 3 issues of a magazine. One of the most popular activities that is available as a separate packet is the Energy Carnival. The Carnival is a set of six games where students combine their academic skills and energy knowledge with their ability to toss and throw just as if they were on the midway. This Carnival is a good culminating activity to test student knowledge of facts.

Energy Placemats

GOAL: To create energy education placemats for distribution to area restaurants for use during NEED Week and/or on NEEDay.

Background

An effective way to create community awareness of NEED and energy is to custom design placemats for use in area restaurants on NEEDay or week. This activity achieves the goal of energy educating as many community members as possible during the annual NEED celebration.

How to Organize

STEP 1. Before making a commitment to using your placemats, the restaurant manager will want to see a sample NEED placemat. Be prepared to have students go early (i.e., January) to the drawing board to develop the placemat design. In designing the placemat, keep in mind specifically what you want people to learn about energy from the placemat. A placemat might have six or more objectives. Develop a list of educational objectives before you even think about sketching the placemat design.

Here are some educational objectives to get you started. Further research of energy education materials will help you develop more.

Upon completion of reading and doing the exercises on the placemat the reader will be able to list:

1. which energy sources are renewable and nonrenewable;
2. the five major sources used today to generate the nation's (or state's) electricity;
3. the major ways of saving energy on the road;
4. four historical facts about the use of energy.

To get the reader to learn this information in a variety of ways you can use crossword puzzles, jumble words, energy trivia facts (Energy's Believe-it-or-Not), find-a-words, or graphs. Examples of these can be found on the reverse side of this page. Two or more activities on the placemat might be directed toward the same educational objectives.

You can also use the NEED logo or the NEED story found on the reverse side of this page on the placemat. You should also leave space for the place where the sponsor(s) name will go or the name of the restaurant sponsor(s), e.g. Sponsored by McDonalds, Main Street Diner. You may want to use two or more colors when having the placemat printed to achieve a really professional appearance. Remember a businessman is not going to put poorly designed mat in his restaurant.

STEP 2. Determine how to list sponsors on the placemat. Some businesses might not want their competitor's name on the placemats to be used in their establishment. In this case you can have the mat printed separately. The printer can easily "strip in" the different sponsors name and print a personalized placemat. Make sure you speak with several printers before hand in order to get the best price and the cost for different printing options.

The price of the placemats should cover all printing costs, development and marketing supplies and all the little other expenses it takes to achieve your goal. You might even be able to get the printer to donate all or part of the printing costs by adding their name somewhere on the placemat. Take your profit an put it towards a NEED activity in the school that requires funds.

STEP 3. Approach the managers of several fast-food restaurants or other restaurants that use placemats at least six weeks before NEEDay. Explain to them the concept of NEED. Show them a copy of the placemat you have designed. Make sure it's the actual size and that paper stock, graphics and printing are in the colors similar to the actual inks to be used.

Ask them if they would like to purchase your custom-designed NEED placemat for use in their establishment on NEEDay or Week. You should also have the request in writing covering the same points from your verbal presentation. Be prepared to leave a sample of the placemat and to wait several weeks for a reply.

STEP 4. Set a deadline for sponsors to contact you. You may have to make a reminder call to some restaurant managers. When all the orders are finalized get everything ready for the printer. Make sure everything is marked correctly so there's no mistakes. A week or more in advance, if possible, deliver the placemats to the restaurant. Be sure to visit the establishment on NEEDay to photograph the placemats in actual use.

STEP 5. **PRIZES --PRIZES --** Enter your placemat design in the NEED Placemat Contest by sending it to NEED Headquarters by April 1. The schools with winning placemats in each of three categories (elementary, junior high, and senior high) will be awarded for first place $75, second place $50, and third place $25.

ENERGY PATROL PACKET
Supplemental classroom activity

Grades: 2 through 8

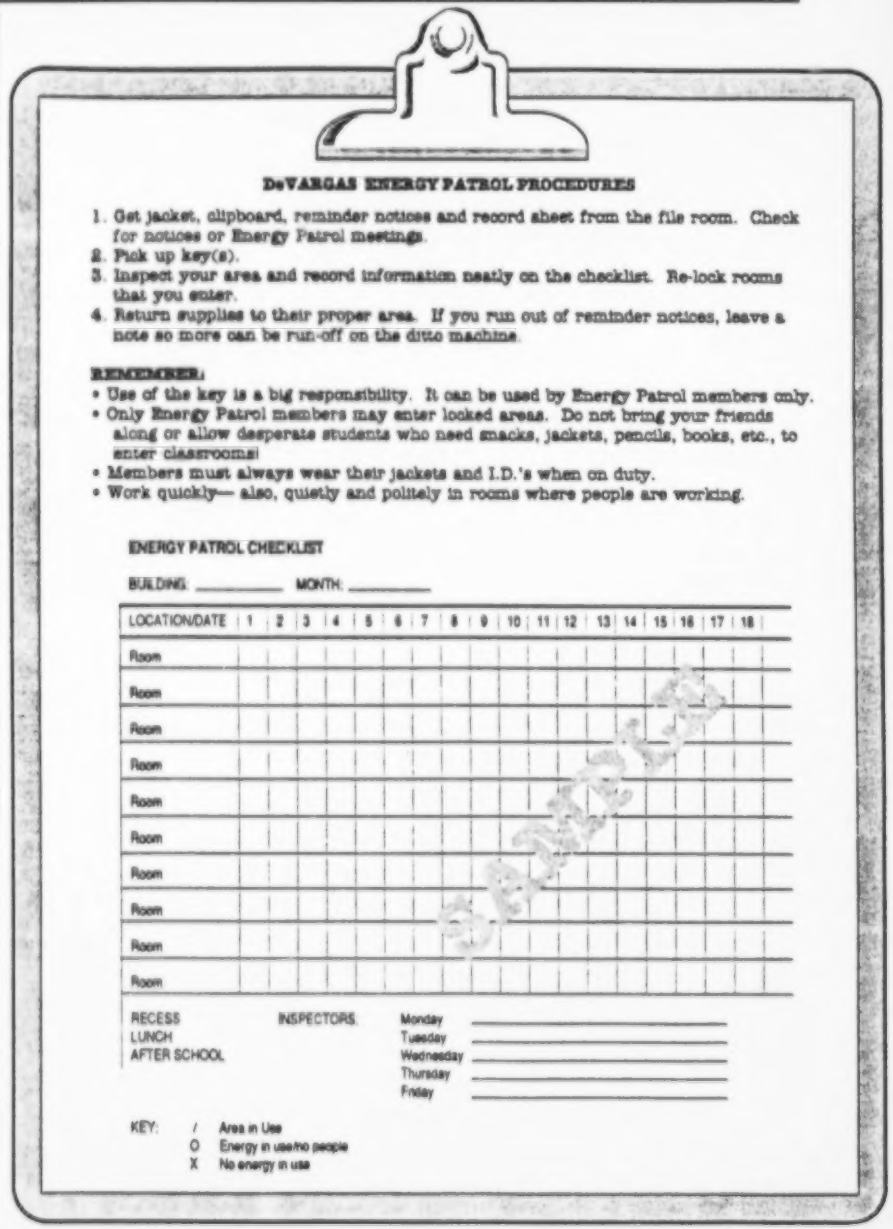
Available From:
California Energy Extension Service
1400 Tenth Street, Room 209
Sacramento, California 95814
(916) 323-4388

Cost: 1 free copy

The Energy Patrol is an example of a concentric circle approach to energy education in that it develops student awareness of their immediate classroom environment and then provides them with an experience in the ever-widening sphere of their school building and home. Simply stated, students on an Energy Patrol monitor classrooms to ensure that lights are turned off when rooms are vacant which can reduce school energy costs by 20% to 30%. In DeVargas Elementary School near San Jose, where the project originated, they saved $1,000 per month, which can be reprogrammed into other activities.

The Energy Patrol works well with classroom learning activities that focus on electricity conservation and encourages kids to keep logs and practice charting and graphing. Lighting audits and meter reading exercises are good background for students. (Such a set of lessons is outlined in Energy Conservation for New York State and Electric Gnus) However, the Patrol does not need to be integrated into the curriculum beforehand but can be implemented as a student leadership activity. If the kids at DeVargas are any indication, the experience will generate interest in classroom energy education!

The 6-page packet includes a description of the DeVargas patrol which has won a national award from the Department of Energy, samples of energy certificates, start-up procedures, checklists and specific information on how to start a Patrol.



DeVARGAS ENERGY PATROL PROCEDURES

1. Get jacket, clipboard, reminder notices and record sheet from the file room. Check for notices or Energy Patrol meetings.
2. Pick up key(s).
3. Inspect your area and record information neatly on the checklist. Re-lock rooms that you enter.
4. Return supplies to their proper area. If you run out of reminder notices, leave a note so more can be run-off on the ditto machine.

REMEMBER:

- Use of the key is a big responsibility. It can be used by Energy Patrol members only.
- Only Energy Patrol members may enter locked areas. Do not bring your friends along or allow desperate students who need snacks, jackets, pencils, books, etc., to enter classrooms!
- Members must always wear their jackets and I.D.'s when on duty.
- Work quickly— also, quietly and politely in rooms where people are working.

ENERGY PATROL CHECKLIST

BUILDING: _____ MONTH: _____

LOCATION/DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Room																		
Room																		
Room																		
Room																		
Room																		
Room																		
Room																		
Room																		
Room																		
Room																		

RECESS
LUNCH
AFTER SCHOOL

INSPECTORS

Monday _____
Tuesday _____
Wednesday _____
Thursday _____
Friday _____

KEY: / Area in Use
O Energy in use/no people
X No energy in use

HOW TO MOTIVATE STAFF AND STUDENTS TO SAVE ENERGY
Classroom and supplemental activities

Grades: 4 through 12

Available From:
California Energy Extension Service
1400 Tenth Street, Room 209
Sacramento, California 95814
(916) 323-4388

Cost: Free

A guide to methods and techniques for classroom use that will involve students in school-wide energy management programs.The activities suggested in this guide are good companions to a more general energy education program because they transform the school site itself into a laboratory of sorts and enable the students to apply concepts they have learned. This publication describes the approaches successfully used by 21 school districts in California that received funding to operate model programs. Using these approaches, these districts saved $2.14 in energy costs for every State dollar invested. Two examples of student word contests are provided. A packet of supplemental quizzes and contests can be requested.

Part One

I. How to Motivate Staff to Save Energy

A. COMMUNICATING WITH STAFF

"I used to leave the lights on in my classroom and the radio playing when I wasn't there, but I don't any more. I have developed some good habits as a result of the (energy) program." (teacher in Newcastle School District)

Staff cooperation and support start with effective communication. Administrators, teachers or certified staff typically do not know how much it costs for energy to operate the school, and are astonished by utility costs. An obvious way to heighten staff awareness of energy waste is to regularly communicate energy costs. How these costs are communicated can make the difference between staff being only mildly interested in saving energy or highly motivated to take an active role in conservation. The impact of energy waste comes to life when energy costs are expressed in numbers of teaching positions or textbooks instead of just dollars. What follows are suggestions for communicating energy use to staff in such a way that generates interest in changing wasteful habits.

1) DISCUSS ENERGY COSTS AND HOW TO REDUCE ENERGY WASTE AT STAFF MEETINGS

One high school had a staff meeting where home as well as school energy management was presented. Two teachers talked a local hardware store into giving teachers at the school a discount on energy conservation purchases (see flyer). The enthusiasm for saving money at home was carried over to saving energy and money at school.

2) DISPLAY LARGE CHARTS SHOWING ENERGY CONSUMPTION IN VISIBLE PLACES

Large charts showing gas and electrical savings can be displayed in conspicuous places such as the cafeteria or a hallway. A class or club can take responsibility for keeping the monthly therm and kwh consumption up to date. In some schools, students read the electric and gas meters daily and graph these numbers. Student interest and questions motivate staff to stay on top of this information.

3) CONDUCT MONTHLY ENERGY CONTESTS ON SCHOOL ENERGY USE

A regular monthly contest to guess electricity and/or gas consumption for the previous month draws attention to school energy use while teaching basic energy facts (i.e., what is a kwh or therm?). Teachers need fun ways to learn information just as students do. In addition to staff competing against each other, their administration of the contests keeps them abreast of the information.

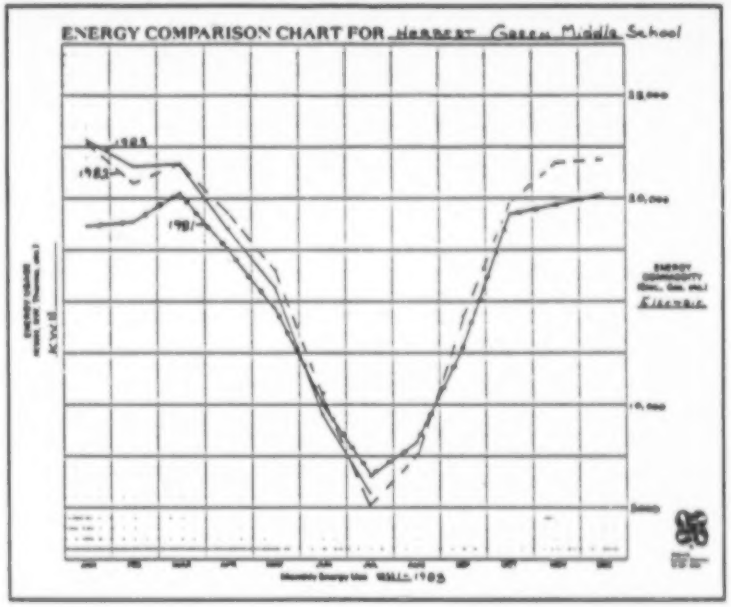
HOW TO ORGANIZE AND COMMUNICATE YOUR ENERGY DATA: A GUIDE TO ENERGY ACCOUNTING
Supplemental materials

Grades: 4 through 12

Available From:
California Energy Extension Service
1400 Tenth Street, Room 209
Sacramento, California 95814
[916] 323-4388

Cost: Free

Once students understand the basic energy concepts, it makes sense for them to use their own school as a laboratory. Tracking the energy usage of the school is one way to do that. Although primarily a guide for administrators, energy managers and energy committees, examples are provided showing how students can be involved. Case studies are included that document how students caught errors in utility bills and saved their districts a substantial amount of money. Actual worksheets provided may be used by business or math classes. This book also helps teachers who want to track the progress of Energy Patrols or supplement lessons in *Electric Gnus* and *Energy Conservation for New York*.



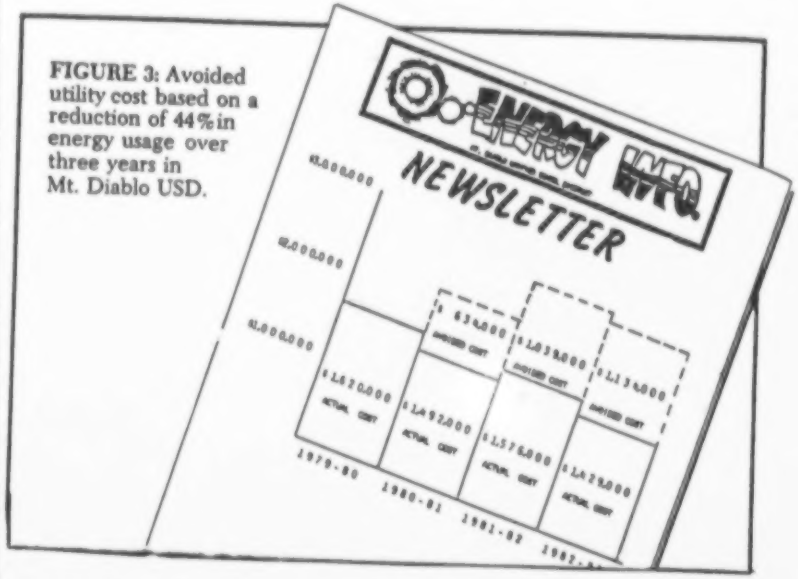


FIGURE 3: Avoided utility cost based on a reduction of 44% in energy usage over three years in Mt. Diablo USD.

COMPUTER SOFTWARE

Grades: 7 through 12

Since 1983, most educational supply catalogs have included a few software programs for energy, but both the quality and educational value vary greatly. Before buying, try to find someone who has used the program or preview it yourself, if possible. Following are a few examples of software identified by the Audubon Society in Massachusetts.

Energy Crossword is for the Apple II and IIe. Energy terms are used in crossword puzzles and a program is included that allows teachers and students to develop their own.

Energy Hangman is built on the popular guessing game, but uses energy words and definitions. It includes software allowing teachers to input their own terms to supplement ongoing activities.

Cost: $20 for each disk and teacher guide

Available From:
Donna Robinson
Alabama Dept of Economic and Community Affairs
3465 Norman Bridge Road
PO Box 2939
Montgomery, Alabama 36105-0939
(205) 284-8937

The next four programs are all for the Apple II, II+, IIe and TRS -80 and grades 7th - 12th unless specified. They include disks, documentation and a teachers guide. The educational value of the programs increases with use of teacher developed units prepared by Jean Sanders at Merrimack Education Center, 101 Mill Road, Chelmford, Massachusetts, 01824, (617) 256-3985.

Electric Bill is for grades 5 on up. It shows how electric bills are computed and how to read bills. Cost: $25

Home Energy Savings can also be used at the 5th grade. It allows students to explore the costs and benefits of making energy conservation changes in a home. Cost: $35

Personal Energy Inventory teaches students about energy consumption by monitoring their energy use. Cost: $39

Power Grid simulates the operation of an electric utility with students bringing individual plants on line to meet anticipated demand. Cost: $59

Available From:
National Science Teachers Association
1742 Connecticut Avenue, NW
Washington DC 20009

A more sophisticated program complete with color graphics and optional sound was developed by Apple II computers by Innovative Communications in 1987 to accompany their Energina series at the junior high school level.

Electrivity, an interactive program that combines a Jeopardy-type game with supporting tutorials. Based on information in the Electricity Choices reference series, the game makes a great self-contained lesson or can be used to accompany any unit on electricity. To play the game, students select the category and difficulty level from 25 squares. Will it be fuels that burn, wind and water, solar, nuclear or power management? The computer randomly chooses a multiple choice question. If the correct answer is chosen, points are awarded. The tutorials include all the information on which the game is based plus true/false mini-games. (The NEED Project has a non-computerized version of Jeopardy.)

Available From:
Many electric utilities in California or
Innovative Communications
207 Coggins Drive
Pleasant Hills, California 94523
(415) 944-0923

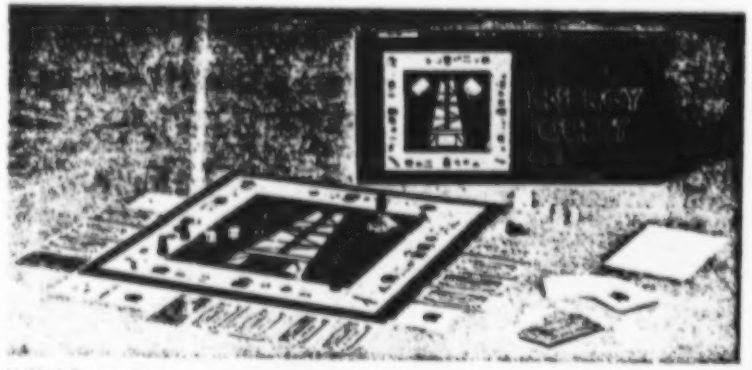
ENERGY QUEST
Boardgame

Grades: 7 through 12

Available From:
Carolina Biological Supply Company
Attention: Ordering Unit
2700 York Road
Burlington, North Carolina 21215
[919] 584-0381 or 1 [800] 334-5551

Cost: $18.10; catalog number: 44-3236 [please include catalog number when ordering]

A game about energy utilities played much like Monopoly. As players move about the board, they purchase energy sites, develop them, and collect money. The game ends with an oil embargo. Includes game board, tokens, cards and play money. Approximate playing time is one hour. For two to six players.



44-3236 Energy Quest

ENERGY & EDUCATION
Newsletter

Grades: Teachers at all levels

Available From:
National Science Teachers Association
5112 Berwyn Road
College Park, Maryland 20740
(301) 220-0870
Jane Ponton, Editor

Cost: $9.00

This bi-monthly newsletter is one of the best places to find evidence of the vitality and innovation in energy education. Each issue begins with a guest editorial which may be authored by the Under Secretary of the U. S. Department of Energy or a classroom teacher and always offers an interesting perspective. "Energy News" highlights what is going on in other states and the federal government. The "Facts Page" gives an update or statistical review of issues. Of primary interest to teachers are reviews/notices of new curriculua and a calendar of events. The Spring supplement is always a Directory of Energy Education Materials. Readers can find everything from lab kits to slideshows, computer software and complete teaching units. The listing, however, is not exhaustive, nor are the materials evaluated or reviewed. Materials are coded by type (curriculum, teaching unit, contest, game, etc.) and grade level.

E&E, December-January 1988

Facts Page

TABLE 2 PART 2: Electricity Sales, Utility (10^9 KwH)

Consuming Sector	1985	1986	% Increase
Residential	792.9	820.8	3.5
Commercial	605.9	630.3	4.0
Industrial	820.3	817.4	-0.4
Street & Highway Lighting	14.6	14.9	2.1
Other Public Authorities	62.2	62.0	-0.3
Railroads & Railways	4.7	4.7	0.0
Interdepartmental	5.3	5.2	-1.9
Total Consumer Sales	2,305.9	2,355.3	2.1

We have also provided some international comparisons (see Table 3), of both the total electrical energy consumed and the per capita consumption. It is interesting to note that the U.S. is not the most electrified nation. Canada with its enormous hydroelectric resources has that distinction. Sweden, not shown in the table, has second place with a per capita consumption of 16, 356 KwH per person.

In total generating capacity, however, the U.S. is far ahead of the others, and now after 10 years of relative stagnation, the utilities are beginning to look forward to a new spurt of growth. The nature and amount of that growth will have an important role in shaping the energy and economic future of this country. *—jmf*

TABLE 3: International Comparisons

Countries	Generating Capacity (MW)	Consumption Total (10^9 KwH)	Consumption Per Capita (KwH/Person)
U.S.	708,795	2,525.2	10,577
U.S.S.R.	319,293	1,544.0	5,564
Japan	169,528	673.4	5,578
Canada	99,284	460.4	18,127
West Germany	92,704	406.7	6,673
France	88,800	326.4	5,927
China	82,200	410.7	396
United Kingdom	67,607	294.7	5,223
Italy	54,976	182.2	3,189
India	51,180	188.5	246

* *Other Sources include cogeneration, etc.*

** *Does not include Other Sources.*

*** *Other includes geothermal, wood waste, wind and solar produced electricity generated by utilities.*

Classroom Resources & Materials

Classroom Project about Nuclear Waste

The American Nuclear Society presents classroom project ideas in their newsletter *Reactions*. The November issue lists a classroom project, which calls for a debate over the disposal of nuclear waste. Students will prepare to debate whether or not nuclear waste can be disposed of properly. Some points made should include the different types of nuclear waste and their hazards, where the wastes come from i.e.—the variety of uses of the atom in everyday life, proposed and existing methods of disposal and their potential effects on society, the environmental costs, and why people are concerned. All students can be involved in research for the debate.

The American Nuclear Society speakers kit "An Introduction to Nuclear Waste and Disposal: Low-Level and High-Level" contains appropriate materials for this activity. It can be borrowed from the Society's free-loan audiovisual library. ANS also offers a free copy of a "Bibliography of Quotes on Peaceful Uses of the Atom and Radioactive Substances." Contact ANS Public Communications Department, 555 N. Kensington Ave., LaGrange Park, IL 60525, or call 800-323-3044.

UTILITY EDUCATIONAL MATERIALS CATALOGS

Grades: Pre-school through College

Major gas and electric utilities in California have Educational Services Departments or Divisions that provide curriculum materials, teacher training and field trips. Many of the materials listed in this Animated Bibliography are available free to teachers in their respective utility service territories. For example, PG&E offers over 100 items including energy education materials, videos, filmstrips, speakers and classroom materials. On the other hand, Southern California Gas only distributes Energy Source materials. SMUD and Los Angeles Department of Water and Power have programs geared especially for their communities. Southern California Edison has a mobile classroom, The Science Connection, aimed at the 5th and 6th grade level and equipped with state-of-the-art equipment.

Los Angeles Department of Water & Power
Educational Services
Public Affairs Divison, Room 1217
Post Office Box 111
Los Angeles, California 90051
(213 481-6358 or 4085
The LADWP has a cooperative arrangement with Los Angeles Unified School District to provide materials through the Regional Science Centers (K-8); Environmental Programs Center (K-8); or Science Materials Center (7-12).

Pacific Gas & Electric
Attention: Ms. Sylvia Hardy
Educational Services, F-2825
77 Beale Street
San Francisco, California 94106
(415) 972-3882
Also: Newsletter

Sacramento Municipal Utility District
Consumer Education
Post Office Box 15830, Mail Stop 10
Sacramento, California 95852-1830
(916) 732-5130
Also: Newsletter and EC hotline

San Diego Gas & Electric
Ernest Roberson
Post Office Box 1831
San Diego, California 92112
(619) 696-4298

Southern California Edison
Educational Services
Post Office Box 800
Rosemead, California 91770
(818) 302-9134
Contact Educational Services Representatives in your local division.

Southern California Gas
Market Services, ML 202N
Attention: Linda Milano
Box 3249 Terminal Annex
Los Angeles, California 90051
(213) 689-3023

Local Municipal Utilities such as Imperial Irrigation District, Modesto Irrigation District, Palo Alto, etc., often provide materials as well.

RENEWABLE ENERGY MATERIALS

Up-to-date information on renewable energy sources can be difficult to find. In response to a growing number of requests, the United States Department of Energy (DOE) has put together some materials for teachers and students. The most immediate source of information is the DOE **CARIERS** toll-free-hotline, which provides basic information on the full spectrum of renewable technologies and energy conservation. For those who require detailed assistance, staff will provide referrals. Call them at (800) 523-2929. Another hotline, **NATAS** has some specific lists that may be useful to teachers including solar energy education projects, audio-visual materials for appropriate technology and catalogs of energy education kits and equipment.

As California utilities begin to have renewable resource installations such as Solar One in Southern California and the Geysers in Sonoma, their curriculum materials also highlight renewables. Pacific Gas & Electric, Los Angeles Department of Water and Power, San Diego Gas & Electric and Southern California Edison, have films and booklets relating to solar, wind, geothermal, hydro and alternatives in general. A number of these are small 15 to 20 page booklets developed by Channing Bete. (Channing Bete has an office in San Francisco at 834 38th Street, 94121, if you would like to contact them directly.) Trade associations are also a good place to look for materials.

A number of the materials presented in the *Bibliography* have particular activities related to specific renewable technologies and are listed along with each description. For the elementary grades, *Get Your Hands On Energy* and *Connections* are good places to begin. For 7th through 9th graders, Innovative Communications has a series of volumes called *Electricity Choices*, distributed by the electric utilities in California. The New York Energy Education Project is excellent for grades 7 through 12. There is one specifically for solar, another on power management and a third on wind and water. At the high school level, or for background information, the Electric Power Research Institute's *Energy Researcher and Reporter* series addresses those technologies which generate electricity. The *T. A. Edison Foundation* has a set of experiments on most renewables, even Ocean Thermal (OTEC)! Be aware that rapid advancements in technologies make even these materials quickly out-of-date.

BIOMASS: A number of materials exist that deal with solid waste problems, although they are not tied specifically to energy. The California Department of Education has interdisciplinary curriculum kits for the 3rd and 6th grades. Both the *Wizard of Waste* (3rd) and the *Trash Monster* (6th) are ten activity units that use comical figures to explore the problems of the "throw- away ethic" and teach students to "reduce, re-use and recycle". Contact the Publications Department at Post Office Box 271, Sacramento, California, 95820-0271 or call (916) 445-1260.

See Solar for Tech-Book series for biomass binder.

GEOTHERMAL: The California Department of Water Resources has a film library with a geothermal listing for the junior high level up. The best film is called *Geothermal: The Roaring Resource* and is about the Geysers area. Excellent instructional design. Utilities with geothermal plants have materials, too, as does Union Oil. Contact UnoCal, Corporate Communications, Post Office Box 7600, Los Angeles, California, 90051.

For Some, Its Potential Is Hot Stuff

By KATHY SHIRLEY
EXPLORER Staff Writer

Nearly everyone realizes that the world must diversify its energy base but few agree on how to do the job. Most alternate energy sources have serious economic and/or technological drawbacks that are stymieing development.

But several major oil companies and some governments are overcoming the hurdles impeding the worldwide growth of geothermal energy — an energy source almost everyone agrees is workable, economical and environmentally safe.

The first attempt to harness the Earth's heat for energy was in 1904 in Larderello, Italy, by Prince Piero Ginori Conti, according to a paper by C. F. Budd Jr., vice president of foreign operations with Union Oil Co. of California's geothermal division. That early attempt led to the world's first electricity power station run on steam.

Today, geothermal-electric generating plants in 15 countries produce about 3,770 megawatts of electricity, and that total is expected to almost double by 1985.

HYDRO: The California Department of Water Resources coordinates a number of water education programs. They put together a 50-page compendium of curricula in a format similar to this bibliography. For the most part, the materials do not emphasize the links between water and energy, but a reference to the Science Framework Addendum at the beginning identifies those that do emphasize the links between water and energy. Several films are also available from their film library on the State Water Project, Oroville Dam and other facilities. Contact Carolyn Tucker at (916) 445-9371, or write DWR, Post Office Box 942836, Sacramento, California, 94236-0001.

"HIS EVIL PLAN WAS TO CHARGE 3 PIECES OF SILVER FOR EVERY GALLON OF WATER TO THE THIRSTY PEOPLE AT THE TRADING POST!"
SORRY, NO CREDIT CARDS!

Compute the daily per capita water consumption for a pioneer family of six if its use totalled as follows:

Cooking/dishwashing: 16 l/day
Drinking: 4 l/day
Handwashing: 11 l/day
Clothes washing: 77 l/week
Bathing: 84 l/week

16 + 4 + 11 + (77 ÷ 7) + (84 ÷ 7) = 54

54 ÷ 6 = 9 l/day per capita

(NOTE: If the students have not experienced the concept of "per capita" before, this lesson provides a good opportunity to introduce it.)

If the family had to carry its water from the town well, how many trips per week would be necessary, using two 20 litre buckets per trip?

(54 X 7) ÷ 40 = 9.45 = 10 trips/week

ZINGER: Given the conditions of the setting, design a water conservation program for this log cabin family and reduce their consumption by 40%.

If the bill was not paid for a year and the family was charged 9% compound interest per month, what would the total bill be?

$15.12 X 1.09 = $16.48	$25.35 X 1.09 = $27.63
$16.48 X 1.09 = $17.96	$27.63 X 1.09 = $30.12
$17.96 X 1.09 = $19.58	$30.12 X 1.09 = $32.83
$19.58 X 1.09 = $21.34	$32.83 X 1.09 = $35.78
$21.34 X 1.09 = $23.26	$35.78 X 1.09 = $39.00
$23.26 X 1.09 = $25.35	$39.00 X 1.09 = $42.51

How much more interest would the pioneers pay in a year if they were charged 9% compound interest/month rather than 9% simple interest/month?

$42.51 – $31.44 = $11.07

ZINGER: This would be an appropriate lesson to use in conjunction with a study of interest in general as it relates to banks, stores, oil companies, etc. Note the recent requirements for companies to advise their customers of the interest rates charged on accounts. You could have the students calculate the annual interest rates, using both simple and compound interest of 9% per month.

SOLAR: The Solar Energy Research Institute (SERI) is responsible for basic research in solar (which technically includes biomass, wind and ocean energy as well as more traditional solar collectors and photovoltaics). They have an excellent set of seven loose-leaf binders, *Solar Tech-Books*, relating to particular technologies. The binders are not designed for teachers, but targeted for a wide cross-section of the speficic and technical community. They are continually updated and include stand alone documents related to the technologies, bibliographies, research directories and research reports. Binders include wind, ocean/tidal, biomass, photovoltaics, active heating and cooling, passive heating and cooling, solar thermal. Much of the material can be accessed through the CARIERS hotline. SERI's Technical Information Branch is at 1617 Cole Boulevard, Golden, Colorado, 80401. Their telephone number is (303) 231-7303.

The Photovoltaic Information Education Association was set up by members of industry, government and education in 1986 to provide relevant information on this emerging technology. One of its main functions is to act as a clearinghouse for close to 1,000 PV modules donated by government and industry. Contact them at 1600 Stout Street, Suite 1100, Denver, Colorado, 80202.

WIND: The California Energy Commission sponsors a wind information center that has technical reports and general publications on siting small turbines, cost and feasibility for systems and directories of manufacturers and contractors. Contact them at (916) 324-3490 or write Development Division, 1516 Ninth Street, Sacramento, California, 95814.

Department of Energy information includes a list of wind equipment manufacturers, research and development in progress, summaries of experimental wind research funded by the DOE, technical and general reading lists of wind energy publications and a "general background" paper. The background piece is probably the most useful for the layperson and students. Call CARIERS or write directly to Wind/Ocean Technology Division, Department of Energy, CE-351, 1000 Independence Avenue, SW, Wasington, DC, 20585.

NON-RENEWABLE ENERGY MATERIALS

For the most part, each of the "fossil fuels" is represented by a well-established trade association that assumes a corporate responsibility to provide instructional aids on energy-related topics. The topics are so specific and the offerings so numerous that they are not reviewed here. For virtually all of the fossil fuels, utilities have educational materials available and are a good first stop. Many have been prepared for the utilities and associations by the same curriculum developers that prepared the materials reviewed earlier, e.g., Innovative Communications, Channing L. Bete.

COAL: This is a minor source for California, but big in some of the states back east. The **American Coal Foundation** gears a number of their materials to teachers. Most are for grades 4 and up.

918 16th Street, NW, Suite 404
Washington, DC 20006, (202) 466-8630

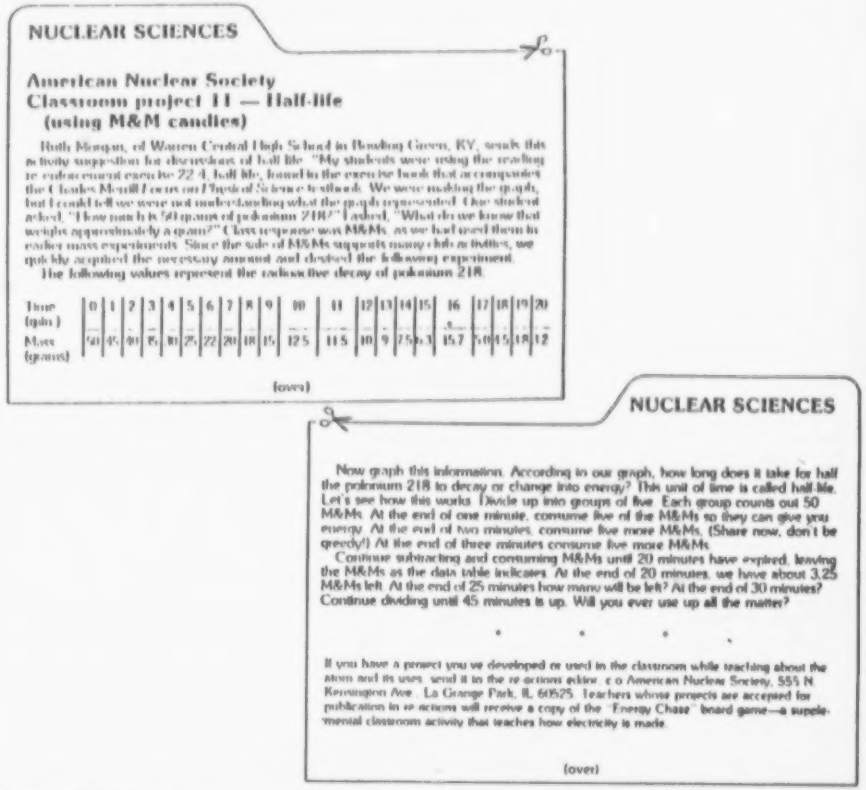
GAS: The **American Gas Association** (AGA), founded in 1918, represents approximately 300 companies involved in the production, distribution and transportation of natural gas. Their teacher advisory panel includes two representatives from California. A catalog of materials including booklets, films, videos, comic books, software and posters for all grade levels is available. Many of the items are available free of charge from gas utilities. Of all the associations, their materials seem most "teacher-friendly".

Educational Programs
1515 Wilson Boulevard
Arlington, Virginia 22209, (703) 841-8676

NUCLEAR: The **American Nuclear Society** was founded in 1954 and members include scientists, engineers and educators working in government, industry and academia. The Society prepares materials for educators interested in teaching about the various peaceful uses of nuclear science and careers in the field. Besides providing a variety of materials and a speakers bureau, they also publish a 4-page newsletter five times a year called *RE-ACTIONS* . A typical issue would include short reports of on-going research, conference dates, free items available, reviews of curriculum, etc. Two of the most interesting features are the "classroom projects" and "notes and quotes". The project is printed in a format like a 3 x 5 card which can be clipped out for a card file. The quotes include trivia items of interest such as, "If the diameter of an atom were the size of a football field, the nucleus would be the size of a pea." The newsletter is printed in brown on white so that teachers may reproduce a portion of it for classroom use.

Re-Actions Editor
555 North Kensington Avenue
La Grange Park, Illinois 60425
(800) 323-3044

Public Information Chair: Lynn Wallis, (408) 925-1149



NUCLEAR SCIENCES

American Nuclear Society
Classroom project 11 — Half-life
(using M&M candies)

Ruth Morgan, of Warren Central High School in Bowling Green, KY, sends this activity suggestion for discussion of half life: "My students were using the trading to enhance enrichment exercise 22.4, half life, found in the exercise book that accompanies the Charles Merrill Exercises in Physical Science textbook. We were making the graph, but I could tell we were not understanding what the graph represented. One student asked, "How much is 50 grams of polonium 218?" I asked, "What do we know that weighs approximately a gram?" Class response was M&Ms, as we had used them in earlier mass experiments. Since the sale of M&Ms supports many clubs activities, we quickly accepted the necessary amount and devised the following experiment.

The following values represent the radioactive decay of polonium 218.

Time (min.)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Mass (grams)	50	45	40	36	30	25	22	20	18	15	12.5	11.5	10	9	7.5	6.3	5.7	5.0	4.5	3.8	3.2

(over)

NUCLEAR SCIENCES

Now graph this information. According to our graph, how long does it take for half the polonium 218 to decay or change into energy? This unit of time is called half-life. Let's see how this works. Divide up into groups of five. Each group counts out 50 M&Ms. At the end of one minute, consume five of the M&Ms so they can give you energy. At the end of two minutes, consume five more M&Ms. (Share now, don't be greedy!) At the end of three minutes consume five more M&Ms.

Continue subtracting and consuming M&Ms until 20 minutes have expired, leaving the M&Ms as the data table indicates. At the end of 20 minutes, we have about 3.25 M&Ms left. At the end of 25 minutes how many will be left? At the end of 30 minutes? Continue dividing until 45 minutes is up. Will you ever use up all the matter?

. . . .

If you have a project you've developed or used in the classroom while teaching about the atom and its uses, send it to the re actions editor, c o American Nuclear Society, 555 N. Kensington Ave., La Grange Park, IL 60525. Teachers whose projects are accepted for publication in re actions will receive a copy of the "Energy Chase" board game—a supplemental classroom activity that teaches how electricity is made.

(over)

The **Atomic Industrial Forum** is an international association of nearly 500 groups from 25 countries involved in the development and utilization of nuclear energy. This is the group to contact for statistics on nuclear power plants or if you want to visit one of the four information centers in California. They also distribute educational materials.

7101 Wisconsin Avenue
Bethesda, Maryland 20814-4891, (301) 654-9260

For those interested in using microcomputers to teach about nuclear energy, give Ron Saltinsky a call at the Monterey County Office of Education, (408) 424-0654.

The **Union of Concerned Scientists** publishes materials that have a somewhat different perspective. They have background materials on radioactive waste, alternatives to nuclear, nuclear power plants in the United States and Three Mile Island. They also have a junior high curriculum on conflict and nuclear war.

Department NSTA
26 Church Street
Cambridge, Massachusetts 02238, (617) 547-5552

OIL: The **American Petroleum Institute** was established in 1919 as the first group to encompass all aspects of the petroleum industry. Publications are handled through their public relations department, although their extensive catalog is composed primarily of technical materials,not classroom aids.

1220 L Street, NW
Washington, DC 20005
(202) 682-8118

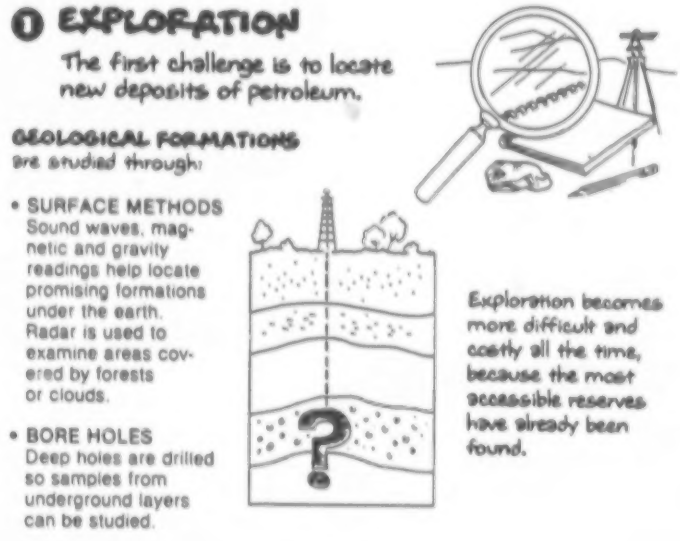
Many oil companies are based in California and are often a better source of materials, films and speakers. **Chevron** has an education division and can provide materials on careers, off-shore oil and environmental considerations along with basic information about oil. Their Land Department has been helpful identifying speakers for off-shore oil issues, (415) 842-3128.

Carrie Murphy
Public Affairs, Youth and Education
575 Market Street, Room 864
Post Office Box 7753
San Francisco, California 94120-7753
(415) 894-5193

Union Oil of California has a poster tracing the history of oil. Contact them at:

Corporate Communications
461 South Boylston Street
Los Angeles, California 90017
(213) 977-7702

For different points of view on offshore oil, you might contact the **Governor's Office of Offshore Development**, c/o Office of Environmental Affairs, 1102 Q Street, Sacramento, California, 95814, (916) 324-3706 and the Natural Resources Defense Council, (415) 421-6561.


1 EXPLORATION
The first challenge is to locate new deposits of petroleum.
GEOLOGICAL FORMATIONS are studied through:
• SURFACE METHODS
Sound waves, magnetic and gravity readings help locate promising formations under the earth. Radar is used to examine areas covered by forests or clouds.
• BORE HOLES
Deep holes are drilled so samples from underground layers can be studied.
Exploration becomes more difficult and costly all the time, because the most accessible reserves have already been found.